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THE METRIC SYSTEM.

By Prof. T. C. MENDENHALL,
PRESIDENT WORCESTER POLYTECHNIC INSTITUTE.

IN the June number of this Journal there appeared a paper on the Metric System, by Herbert Spencer. It was originally published as a series of anonymous letters in the London Times, in the course of a discussion growing out of proposed legislation by the English Parliament. They aroused little interest among metrologists, except as examples of "curious and interesting reading," until their authorship was acknowledged by Spencer. No little astonishment was created by this announcement, and as a matter of fact, owing to the extraordinary character of the letters and the great fame and reputation of Mr. Spencer, the statement was not at first credited by many. Indeed, messages were sent to London, inquiring, "Who is this Herbert Spencer who is writing about the metric system?" These things are worth mentioning, to show the surprise everywhere manifested, not on account of the fact that Mr. Spencer was opposed to the adoption of the suggested reform in weights and measures, but rather at the singular arguments which he advanced in defense of his position. Without a single exception they had all been traversed more than a quarter of a century ago; their inherent weakness and entire lack of philosophic consistency had long ago been pointed out; and it is perfectly safe to say that, with possibly one exception, they are such as no one familiar with the progress of metrology during the past quarter of a century would think of offering at the present time, however strongly opposed to the metre and its derivatives he might be. The great influence which everywhere and always goes with the name of the distinguished

author of these letters, and this alone, compels those who are advocates of metrological reform to offer some reply to the propositions which he has advanced, and a brief analysis of them will now be undertaken, with the hope of showing that they are either fallacious or utterly inapplicable to the question under consideration.

As Mr. Spencer begins by declaring that the "advocates of the metric system allege that all opposition to it results from ignorant prejudice," which he very properly declares is far from true, it may be well to say that, in the opinion of the writer, there is relatively little of that sort of thing to contend with in the United States. What is far more dangerous as an obstacle to human progress, and often far more common, is what may be called "intelligent prejudice," meaning thereby an obstinate conservatism which makes people cling to what is or has been, merely because it is or has been, not being willing to take the trouble to do better, because already doing well, all the while knowing that doing better is not only the easier, but is more in harmony with existing conditions. Such conservatism is highly developed among English-speaking people on both sides of the Atlantic, and is likely to turn up in the most unexpected places. It is often a phase of ancestral or national pride, and finds its expression in the feeling that whatever pertains to one's own race or country is, on the whole, better than anything else of its kind. Those who are under its influence are adepts in finding ingenious reasons and excuses in defense of an attitude toward reform which they must know to be founded on neither logic nor fact. These people are numerous among opponents of reform in coinage, weights, and measures, and, as already noted, it is with this class that the most serious difficulty is encountered. "Ignorant prejudice" generally disappears when ignorance disappears, and fortunately in the present instance the system which it is proposed to substitute for that already in use is so extremely simple that it can be learned and understood in a few minutes, while certainly no one man has ever, in an entire lifetime, completely mastered the "customary weights and measures" in use in England and America.

It will be convenient to consider the objections offered by Mr. Spencer in the order in which he has presented them in the four separate letters which go to make up his article.

In the first he has reproduced in quotation a considerable part of the well-known argument of Sir John Herschel, written and widely published over thirty years ago. The inconsistency and utter worthlessness of this have been so long recognized that one has a curious feeling of fighting a straw man in attacking it at this time.

Sir John Herschel claimed, first, that the metre was not exactly the ten-millionth of the terrestrial meridian passing through France, which was entirely correct, and that, therefore, it was not a good unit for international use, which does not at all follow. He further attempted to show that the polar radius of the earth, which could never be known except indirectly, was a better unit than the quadrant, a large part of which could be measured directly, and that this radius differed by only eighty-two yards from 500,500,000 English inches. He then proposed to increase the English standard by its one-thousandth part, so as to furnish what he declared would then be "a system of linear measurement the purest and most ideally perfect imaginable." It has always been a surprise that so able a mathematician and astronomer could have overlooked the inherent weakness in such an argument. To those who have followed the history of this subject it is unnecessary to say that for many years no metrologist has thought for a moment of relating the standard of length *accurately* to any terrestrial dimension. The precision of our knowledge of the figure and dimensions of the earth, now and for many years to come, is such as to forbid this, even if there were no other arguments against it. In the light of current geodesy Sir John's calculations themselves furnish a curiously interesting proof of this. The argument with which he opposed the metre may to-day be turned with equal force against his proposed "ideally perfect" inch. According to the latest determination of the polar radius of the earth, his eighty-four yards become more than one thousand yards, and if his scheme had been adopted when proposed it would have been as badly "out of joint" with Nature as is the metre.

The simple facts are that while in the beginning the metre was made to be as nearly as possible one ten-millionth of the meridian, no one imagined that it could be exactly so, or rather that we could ever know that it was exactly so. It is sufficiently near that value to be very convenient in calculations relating to terrestrial distances and areas, but it must always be considered as defined by a *material standard*, and no metrologist ever thinks of it in any other sense. Within a few years Michelson has devised a method of measuring light waves with an accuracy hitherto unthought of, and has measured the length of several such waves in terms of the international prototype metre at Paris, so that we have the metre related to what we may assume to be an invariable dimension in Nature, with a degree of accuracy extremely satisfactory at the present time. But this does not alter the fact that it is and must be regarded as an arbitrary unit represented by a material prototype. Keeping this fact in mind, it will not be necessary to point out the total irrelevancy of Herschel's argument.

Something must be said, however, of the sentence which Mr. Spencer has quoted in which, referring to his proposed plan for relating units of length to units of weight and capacity, Herschel says, "And thus the change which would place our system of linear measure on a perfectly faultless basis would at the same time rescue our weights and measures of capacity from their present utter confusion."

It is usually considered to be hardly fair to pick a single sentence out of a group and quote it as representing the views of another; and *cutting a sentence in two in the middle, when the last half is against you,* is a practice so generally condemned that we are compelled to believe that Mr. Spencer must have accidentally fallen into it in this instance. Indeed, if full quotation had been made of what preceded this sentence and upon which it is founded, the one, rather meaningless, argument against us would have been changed to two very good points in our favor. Sir John suggested that the inch be increased by its one-thousandth part, so that it might be one five-hundred-millionth of the polar radius of the earth. He then undertook to show that by increasing the *grain* (by legislative enactment) by its one-eighteenth part, a cubic foot of water would weigh one thousand ounces, thus furnishing a decimal connection between the unit of weight and that of volume. This interesting scheme affords another illustration of the danger of patching up old and unsatisfactory systems, for a recent determination of the weight of a cubic inch of water by Mr. Chaney, in charge of the imperial standards in London, reveals the fact that the quantities on which Herschel based his calculations and suggestions were in error many times greater than was the metre, against which his arguments were directed. The complete sentence, of which Mr. Spencer quoted one half, as above, is as follows: "And thus the change which would place our system of linear measure on a perfectly faultless basis would at the same time rescue our weights and measures of capacity from their present utter confusion, *and secure that other advantage, second only in importance to the former, of connecting them decimally with that system* on a regular, intelligible, and easily remembered principle; and *that* by an alteration practically imperceptible in both cases, and interfering with no one of our usages or denominations." The words following "confusion" were omitted by Mr. Spencer, and they have been italicized to invite attention to their great significance as showing that the *decimalization* of the new system of weights and measures was earnestly sought for by Herschel. That Mr. Spencer is violently opposed to this can only with great reluctance be accepted as a reason for the abrupt termination of his quotation.

Before beginning the exposition of his own views he ventures

to quote another objector to the metric system in the person of Prof. H. A. Hazen, of the United States Weather Bureau, who some time ago argued that its adoption would necessarily include that of the centigrade thermometer scale, and that as, in his opinion, this was very bad, the metric system must be very bad. Among meteorologists and physicists this reference will be thought to be singularly unfortunate, and it furnishes a striking illustration, among the many to be found in the article under review, of Mr. Spencer's inability to recognize or properly estimate "values" in regions of thought to which, it must be admitted, he is comparatively a stranger. However much one might doubt the conclusions reached by Sir John Herschel, his splendid career as an astronomer and exponent of exact science commands the respect of all lovers of real learning. When we consider that, first, the centigrade thermometer scale has no more to do with the metric of weights and measures than with the coinage of the United States, and, second, its advantages over the unscientific and awkward scale of Fahrenheit are so many and so great that it is already well-nigh universally used, and almost absolutely so among scientific men of all races and nations, it is apparent that no time need be wasted in commenting upon a statement which, by its juxtaposition with that of Herschel, has already achieved a notoriety to which it has no claim either by reason of character or ancestry.

In his second letter Mr. Spencer's own arguments begin to be developed. He first objects to the metric system because, although it is a century old, it has not yet, even in France, entirely driven out some of the old denominations and units. In reply to this it may be said that little research is required to reveal innumerable examples of persistence in the use of words and things for more than a hundred years after their betters were available. On this point I will imitate Mr. Spencer by quoting from a letter recently received from a well-known man of science and admirer of our distinguished opponent. He writes: "This is amazing when coming from Spencer. He says on page 189, 'But one might have thought that after three generations daily use of the new system would have entailed entire disappearance of the old, had it been in all respects better.' Now Spencer knows better than any one else the persistency of habit in all people. A volume a foot thick might be written on the persistence of habit."

The next objection is worthy of more serious consideration, and it has been given (for it has long been discussed) a good deal of weight by many thoughtful people. It refers to the alleged universal tendency to continual bisection, thus leading to the use of halves, quarters, eighths, sixteenths, thirty-seconds, sixty-

fourths, and, sometimes in subdividing the inch, one-hundred-and-twenty-eighths. To begin with, the existence of any such inherent tendency is quite open to discussion, but, without going into that, it is at least plain that it has never shown itself in the evolution of systems of weight and measure. In evidence of this the following tables of English measures of length and weight may be cited, and, that there may be no mistake, they are drawn from a text-book on arithmetic written by one of the most distinguished of England's nineteenth-century mathematicians:

Length.		Weight.	
3 barleycorns are	1 inch.	27 11/32 grains are	1 dram.
12 inches are	1 foot.	16 drams are	1 ounce.
3 feet are	1 yard.	16 ounces are	1 pound.
5½ yards are	1 pole.	28 pounds are	1 quarter.
40 poles, or 220 yards, are	1 furlong.	4 quarters are	1 hundredweight.
8 furlongs, or 1,760 yards, are.	1 mile.	20 hundredweights are .	1 ton.

These are far from being complete, for two or three additional tables are necessary to fully exhibit the units and ratios for both length and weight, and they are even more irregular in construction than those shown above. In all, as well as in the English money units and denominations, there is no indication whatever of this "natural tendency" toward continual halving. It *is* a common practice, possibly growing out of a tendency in some degree natural, to *continually bisect a single unit,* and this is likely to be the case under any system of weights and measures, and to it there can be no sort of objection. It is important, however, to note that this is in no way related to the question of desirable or convenient ratios of units, and that it has practically no weight whatever as a criticism of the metric system.

But even if this were not true, it would weigh vastly more against the systems in customary use in England and America than against the metric system. What possible objection can there be to speaking of a half or a quarter or an eighth of a mile or rod or yard or inch, if one wishes to do so? And no more can there be to a half, quarter, eighth, or sixteenth of a kilometre, kilogramme, metre, gramme, centimetre, millimetre, etc., nor, again, to the use of such fractional parts as thirds, fifths, or sevenths, if they seem to be desirable. But to compare the two systems in this respect one should undertake such a problem as finding the value of a third, quarter, fifth, or eighth of a mile or a ton in rods, yards, feet, and inches, or hundredweight, pounds, ounces, drams, and grains, and then do the same thing in the metric system. The enormous superiority of the latter will at once be revealed.

On the other hand, it can not be denied that there is, and has been for many years, a strong tendency toward the *decimal* sub-

division of single units, even among users of our own clumsy system of weights and measures.

In weight, for instance, we in the United States have long ago decided that a hundredweight shall be a hundred pounds, as its name implies, and not a hundred and twelve as in England, and our ton is almost universally two thousand pounds, although we still retain the traditional ton of twenty-two hundred and forty pounds in certain transactions; and as if to emphasize the utter absurdity of the thing, in some parts of New England a "long" or "gross" ton of coal weighs twenty-two hundred pounds. In many extensive calculations the avoirdupois pound is adopted as the only unit of weight, and fractional parts are expressed in tenths, hundredths, etc.; and this is found to reduce the labor of such calculations enormously. In length measure the tendency toward decimalization is still more marked. In land surveying and in engineering operations it is now the all but universal practice to use the foot as the unit and multiply and divide decimally. Even in the traditional "surveyor's chain," with its one hundred links, each being 7·92 inches in length, there was a serious attempt to secure some of the advantages of decimalization, but it is quite superseded now by the one-hundred-foot tape, with its divisions of ten feet each, and each foot divided into tenths, etc. In reference to the chain, a quotation from the book from which the tables given above are extracted, will not be without interest. After explaining that by a rather laborious process the following measures of surface may be derived:

144	square inches	are	1	square	foot,
9	" feet	"	1	"	yard,
30¼	" yards	"	1	"	pole,
40	" poles	"	1	rood,	
4 roods	are		1	acre,	

the author remarks: "Thus the acre contains forty-eight hundred and forty square yards, which is ten times a square of twenty-two yards in length and breadth. This twenty-two yards is the length which land-surveyors' chains are made to have, and the chain is divided into one hundred links, each 0·22 of a yard or 7·92 inches. An acre is, then, ten square chains. It may also be noticed that a square whose side is sixty-nine yards and four sevenths is nearly an acre, not exceeding it by a fifth of a square foot." This is a fair example of the beautiful simplicity of a system which all English-speaking people are assumed to understand and which many of them are reluctant to give up.

Again, in accurate machine-shop practice the use of decimal divisions is becoming almost universal. The unit is generally the inch, and it is subdivided into tenths, hundredths, thousandths, etc. "True to one hundredth, or one thousandth, or one ten-thou-

sandth of an inch" is heard a hundred times oftener in every shop than "correct within a sixty-fourth or a hundred and twenty-eighth, etc.," and it means not only greater convenience of expression and measurement, but an actually higher standard in precision of workmanship. To the objection, then, that the tendency of mankind is toward a binary rather than a decimal division of units, which is almost the only one offered by Mr. Spencer worthy of serious consideration, we may briefly reply by saying that even granting it to be a fact, it has no bearing whatever on the questions of *ratios* and *relations* of units, which is what distinguishes one system from another; that such a tendency may find expression in one system as well as another, and certainly with infinitely greater facility in the metric system than that now in use among English-speaking people; and, furthermore, that the estimation of fractional parts by tenths or hundredths is believed by many who habitually work that way to be both easier and more accurate than by halves, quarters, eighths, etc., and as a matter of fact the prevailing tendency is away from the latter and toward the former.

Mr. Spencer seems to have a painful satisfaction in the fact that in California the "bit" is still used, or was about twenty years ago—painful, because he feels obliged to characterize it as a "retrogression." As already said, it ought not to be necessary to remind him of the slow changes in human customs. Even in the time of John Quincy Adams the word "dime" (which began life as *disme*) was almost unknown and the coin itself very nearly so, for the shilling in all its multiplicity of forms and values still held place. Even now the shilling, bit, sixpence, "levy," etc., are not unknown in parts of the United States, but their presence serves only to emphasize the enormous superiority of our decimal system of coinage over that which, happily, our forefathers had the courage to throw off. He also expresses surprise that we have a quarter of a dollar, and that he does not see things advertised to sell for one dollar and three dimes or four dimes, etc.

He has here unconsciously called attention to one of the most important features of a decimal system—that, in fact, upon which its great superiority depends—namely, the ease with which changes from one denomination to another are made, and the consequent almost universal reference to a single unit. Some comment on the English money system in respect to this feature will be made later, but in illustration of this remark it may be said that nobody who understands the money system of the United States ever thinks of expressing any given amount in eagles, dollars, dimes, cents, and mills, but in dollars only. Everybody, however, can instantly convert any expressed amount into any one or all of these. Compare, for instance, $432·873 and £85 7*s.* 8¾*d.*,

and consider the memory and labor demanded to convert the former to eagles, cents, or mills, or the latter to pounds, shillings, pence, or farthings. Our eagles, half eagles, quarter eagles, half dollars, quarters, dimes, five-cent, three-cent, two-cent, and one-cent pieces come and go as public convenience demands, and they do not give us the slightest inconvenience in calculation or account; for their units are decimally related to each other and they are invariably mentally referred to the one money unit, the dollar.

Among the several irrelevant and long-exploded arguments urged by Mr. Spencer, none is "more so" than his Socratic attempt to "array Nature" against the metric system, and it might well be passed over on account of its suicidal character. It may be worth while to remark, however, that the use of the decimal system in dividing the arc of a circle is not in the slightest degree "against Nature," that it is even now being strongly advocated by many eminent European geodesists and astronomers, and that it would be a very decided advance, if brought about, as, in the opinion of many, it some time will be. But it has nothing whatever to do with the metric system of weights and measures. Also, that whenever the English Parliament or the American Congress shall have under consideration an act providing that the year shall consist of ten months, the week of ten days, etc., it is likely that Mr. Spencer will have little difficulty in finding people ready to discuss the merits of such a measure. But these things have no place in the metrological reform under consideration, and their being brought into the discussion occasions no little surprise among those who are accustomed to expect from so eminent a scientific man as Mr. Spencer something like a fair and logical presentation of at least one side of a question.

There appears, however, one inference in reference to the division of a compass dial that is worthy of attention; it is that so inherent is the habit of halving and rehalving that the thirty-two-point division is fixed beyond all hope of change. On the contrary, the practice of ignoring this division is constantly growing, and to such an extent that now a large number of sailing charts and many compasses show circles divided into degrees instead, and many a man at the wheel has told me that he prefers to have the course laid in that way.

But the most astonishing part of Mr. Spencer's argument is yet to come. As he proceeds with his entertaining but somewhat one-sided dialogue, hints of something mysterious begin to appear. The objections to universal decimalization (which nobody has proposed) are put in evidence one by one until the man on the wrong side is led to exclaim in dismay: "You astonish me! What else is possible?" In answer he is asked to join in the contem-

plation of the fact that decimal notation grew out of the possession of a bundle of ten fingers, and the distinguished author might have declared, in harmony with what he has said before concerning time and circular measure, that it was in a very large degree "dictated by Nature." But while affirming that time and the compass have been so riveted upon us as to defy any attempt to change, he leads gradually up to the conclusion that counting by tens is not the only way of counting, and that Nature's group of ten units doesn't mean anything in particular after all. Attention is then called to the greater divisibility of the number twelve, furnishing aliquot parts "which in sundry cases Nature insists upon"; to the fact that we have twelve ounces in a pound (we have also sixteen), twelve lines to the inch, twelve sacks to the last (whatever that may be, De Morgan fails me here), twelve things in a dozen, and that our multiplication table goes up to twelve times twelve! While admitting that "*these particular twelve divisions are undesirable*, as being most of them arbitrary and unrelated to one another," he maintains that they "make it clear that a general system of twelfths is called for by trading needs and industrial needs." No time for breath-drawing is allowed after this astounding bit of logic before one is confronted with the following: "It needs only a small alteration in our method of numbering to make calculation by groups of twelve exactly similar to calculation by groups of ten; yielding just the same facilities as those now supposed to belong only to decimals. This seems a surprising statement, but I leave you to think about it, and if you can not make out how it will be I will explain presently."

In the original chronology of these letters as they were published in the Times it appears that Mr. Spencer's readers were allowed two days in which to think over this "surprising statement," and to recover from any condition into which they might have been thrown by its announcement. I can not refrain from saying just at this point that thousands of American schoolboys would have needed only two minutes in which to explain how it might be done, for it has been common knowledge among arithmeticians from the earliest days of the study of the properties of numbers. In the third letter, however, the thing is gone into at great length, and Mr. Spencer generously shares with the reader the knowledge that it is only needed to invent two characters to stand for ten and eleven, and then we should have a system suited to a twelve-fingered race and greatly superior to the decimal system now in use. It is useless to repeat that all this is old, very old, and it is but justice to Mr. Spencer to repeat that he prepared it from memoranda of his own made more than fifty years ago. No one denies that much advantage might come

from a change in the radix of our numerical system, and some advantages of the present might be lost. An increase in the radix has been recommended for the greater power in computation it would afford, and its decrease has been advocated, even to the extent of suggesting the use of the binary system in which there is but one significant figure, on account of the consequent great simplicity of all calculations. It seems almost certain, however, that, "dictated by Nature," as it is, it will never be changed, as the advantages on either side are small when compared with the magnitude of the problem of a new radix. There are some people who would defer any improvement in our system of weights and measures until the decimal system of notation can be wiped out and one with sixteen as radix substituted, so that if Mr. Spencer was able to bring about such a change as he suggests he would find that his favorite number, twelve, was not alone in the field of candidates for adoption as the foundation of the new notation. Indeed, it is a well-known fact that in the evolution of number systems those not decimal have had their day, but none have survived competition with the many advantages pertaining to that growing out of the "bundle of ten fingers."

In his fourth paper Mr. Spencer again resorts to quotation, and brief reference should be made to the arguments set up by some of his authorities. The letter of Sir Frederick Bramwell contains some remarkable statements. His assertion that the new system will require "more figures to perform ordinary sums than on our present system, when rightly applied," is so grossly incorrect, as may be easily proved by a few examples, that no time need be spent in controverting it. The same might be said of his further assertion that it is more likely to lead to error, and, above all, to the common error in placing the decimal point. This last statement is frequently made, and it is worth while, therefore, to call attention to the fact that in all ordinary business transactions in which the decimal system is used, and in all calculations, for that matter, the error of a misplaced decimal point is one of the rarest of all errors. This is because of the generally quick and certain detection of such a mistake. To misplace the decimal point by the smallest possible amount is to change the result tenfold, and usually so great an error is instantly detected by means of approximate knowledge or other checks. Take our own money system, for example: it is perfectly safe to say that other mistakes are a million times more frequent than a persistent, undetected misplacing of the decimal point. Yet, curiously enough, considerable weight has been given to this objection to the metric system of weights and measures, which is, on the contrary, vastly less liable to errors of computation than that now in use.

Sir Frederick also furnishes an extensive extract, giving the views of the first Napoleon on the subject of reform in weights and measures. Many of the stock arguments are repeated, and if they had not been thrashed over long ago it would be perfectly easy to take them up one by one and show their absurdity. An entire lack of any really accurate knowledge of the subject and an absence of any sort of conception of the simplest metrological principles are shown in a single quotation: "A toise, a foot, an inch, a line, a point, are fixed portions of extension, which the imagination conceives independent of their relations to one another; if, then, we ask for the third of an inch, the mind goes into instant operation. The length called an inch is divided into three parts. By the new system, on the contrary, the mind has not to divide an inch into thirds, but a metre into a hundred and eleven parts." It is difficult to properly characterize such utter nonsense; but, fortunately, the French people, who are to-day the leaders in the world's metrology, were not obliged to take their science, as they were most other things, from the first consul. A group of the most distinguished Frenchmen of any period had perfected this system, even in the very midst of the bloody revolution which closed the last century, and when their final report was made in an address to the legislative chambers by the celebrated La Place, the event was described by Adams as a "spectacle at once so rare and so sublime . . . that not to pause for a moment, were it even from occupations not essentially connected with it; to enjoy the contemplation of a scene so honorable to the character and capacities of our species, would argue a want of sensibility to appreciate its worth. This scene formed an epoch in the history of man. It was an example and an admonition to the legislators of every nation and of all after times."

Mr. Spencer also quotes from an auditor who had to go over £20,000 of accounts, and who was "very thankful that it was not in francs." At first blush it seems entirely natural and creditable to him as an Englishman to rejoice that his twenty thousand is in pounds sterling rather than francs; but, after all, his remark is only a reflection of that not uncommon English sentiment that the imperial monetary system is more perfect than any other in all the wide world. This sentiment is doubtless the outgrowth of national pride and intellectual inactivity; it is not entertained by the majority of the more thoughtful and scholarly Englishmen, and, furthermore, it is in every respect false. It is unnecessary to consume time in quoting the opinion of England's most distinguished scholars, to show that this is not simply an example of American boasting, but I will venture to illustrate by one or two additional extracts from De Morgan. In his arithmetical appendix on Decimal Money he says: "Of all the simplifications of

commercial arithmetic none is comparable to that of expressing shillings, pence, and farthings as decimals of a pound. The rules are thereby put almost upon as good a footing as if the country possessed the advantage of a real decimal coinage." He then proceeds to develop rules by means of which any sum of English money may be expressed in pounds and decimals exactly as our money is always expressed in dollars and decimals, so that any required operation may be easily performed by the common rules of arithmetic. After this the decimals of a pound must be reduced back again to shillings, pence, and farthings. To show how the English system lends itself to easy calculation, I quote his rule, which is only approximately correct, for making the latter reduction: "*A pair of shillings for every unit, in the first place; an odd shilling for fifty* (*if there be fifty*), *in the second and third places; and a farthing for every thousandth left, after abating one if the number of thousandths left exceed twenty-four.*" Can anything be more charmingly simple and easily carried in one's head than this ?

I must be content to stop without reference to a few other points raised by Mr. Spencer, for they are essentially all of a kind. There is a sentiment underlying much of his argument, to which I must briefly refer, however, because it has shown itself in other recent discussions of this subject. I refer to an anxiety lest the "poor man" be in some way injured by the proposed reform. It has come to be the fashion in all political or economical controversies to exhibit a consuming interest in the poor man's welfare; indeed, one marvels that there should continue to be any poor, so universal and so intense appears to be this anxiety to shield them from all harm. Fortunately, the so-called "poor man" is not so blind to his own interests as some would have it appear, and he is quite alive to the fact that the proposed metrological reform is fully as important to him as to anybody.

Finally, it ought to be understood that the advocates of the metric system do not assume that it can come into use immediately or without considerable hardship. It took nearly a century to fairly establish our decimal money system, which no one would now think of giving up. During all this time old units and denominations continued to be used in a lessening degree, although not authorized by law. Something of the kind must occur in the transfer from our illogical, brain-destroying, time-consuming system of weights and measures for the more perfect system for which it is sure to make way. Furthermore, they heartily welcome and desire the presentation of all arguments against or objections to the metric system, believing that the more widely it is known and discussed the more supporters it

will have. They expect to meet occasionally such "intelligent prejudice" as is exhibited by Mr. Herbert Spencer, whose contribution to the discussion of the subject is sure to be considered in the years to come as altogether the most remarkable to be found in any time or tongue.

NEVADA SILVER.

By CHARLES HOWARD SHINN.

A THIRD of a century ago the surface bonanzas of the Comstock began to yield their treasures. Californians long skilled in gold mining were rushing by thousands into the newly discovered silver districts, and prospecting the mountains and deserts east of the Sierras. In fact, the whole Pacific coast was ringing with shouts of "On to Washoe!" In a few years this obscure, long-neglected corner of western Utah became the State of Nevada. It developed a multitude of mining camps besides the Comstock; it created new forms of mining skill, maintained vast dependent industries, contributed revenues to distant cities, sent forth new groups of millionaires, gave to the world new types of frontier character, and added a dramatic chapter to the story of American commonwealths.

The land itself is worth a moment's attention. It is a high plateau, gridironed by short, parallel mountain chains, the most noted of which is the Washoe Range, separated from the Sierras by a line of small Alpine valleys, and rising, in Mount Davidson, to a height of 7,827 feet. East, south, north, extend weary miles of desert, relieved by a few oases. The scanty rivers of Nevada soon lose themselves in alkaline basins. According to an old frontiersman, reported by Dan De Quille, "the Almighty once started out leadin' a number of small rivers along, meanin' to unite them into one large one, and take it to the Pacific. But before he had more than started it grew late Saturday night, so he tucked the ends down into the sand, where they have remained ever since."

Stephen T. Gage, of the Southern Pacific Railroad, tells an interesting story of Horace Greeley's journey across the continent. The distinguished editor had reached Placerville, California, and had been met by a few ardent followers on horseback. The boisterous mountain town was politically opposed to Greeley, but when the group of young men, of whom Gage was one, brought him out on the plaza for a speech, a great crowd assembled.

"I believe," said Greeley, "that God never made anything without a purpose. But the wilderness that I have crossed is

certainly worthless for agriculture. Unless there shall prove to be great mineral wealth there, it has been created in vain. But if, in the workings of Divine Providence, vast treasure houses are revealed, as I believe there will be, then, my friends, it will take the labor of a hundred thousand California miners a hundred thousand years even to prospect it!"

Even while Greeley spoke a small group of ignorant prospectors, climbing the cañons that slope south from Mount David-

CARSON RIVER CAÑON.

son, were approaching the Comstock ledge. They were, in fact, already filling their rude sluice-boxes with decomposed rock from the giant lode, and were washing out a little gold, while they threw many a lump of nearly pure silver down the gulches with loud imprecations because the "blue stuff" clogged the machines. These miners were the remnants of several larger camps that had grown, flourished, and fallen into ruins in western Utah during eight or ten years, but they were not the first settlers of the Nevada region. The Oregon trail had three thousand emigrants

on the road in 1846, and as soon as the shout, "California gold!" was heard, the deep-trampled highways across the desert began to be strewed with wrecks of wagons and bodies of horses and oxen. Thousands of men made camp after camp in western Utah without washing out a panful of dust or breaking off a specimen of quartz. Meanwhile Mormon traders, anxious to sell supplies to wagon trains, established small stations along the trail. These traders were often colonists sent out from Salt Lake, under strict orders not to cross the mountains and not to mine for gold. According to a letter in the Sacramento Transcript of October 14, 1850, the hungry emigrants were often forced to sell "a horse, an ox, or a mule for twelve, ten, or even two pounds of flour," and in 1849 matters must have been even worse.

Placer gold was found in the winter of 1849 in a small gulch near Carson Valley, and one or two men worked the deposit, with poor results. The wandering Mormons abandoned their trading posts, but in 1851 Colonel Reese, from Salt Lake, made a permanent settlement. With him came, as teamster, bibulous, feather-brained James Fennimore, afterward known on the Comstock as "Old Virginia," who soon began placer mining in "Gold Cañon." By November the Carson region contained about twenty settlers; miners, herdsmen, and nomads of every description increased the whole population of western Utah to nearly one hundred. Squatter government began, and Congress, with unconscious humor, was petitioned to create a separate Territory for this handful of settlers. The Utah Legislature, with equally unconscious humor, endeavored to hold the region by dividing it into seven huge parallelograms of counties, only one of which appears to have contained any people. The judge sent to Carson County was referred by the Gold Cañon miners to their local "rules, usages, and customs," adopted in the main from California camps.

Local traditions contain much that is worth passing notice. Israel Mott, for instance, "built his house out of the beds of abandoned emigrant wagons." "Ragtown," on the Carson, received its name because of vast heaps of rubbish that marked the camp where the incoming host "ran into the water waist deep to drink like animals," and threw their desert-worn garments in heaps on the cacti and sagebrush. The last night of 1853 there was a dance "in the log house over Spafford Hall's store" at the mouth of Gold Cañon. Eight women were present, and this number constituted "two thirds of all the white women in western Utah." Of white men there were about a hundred—from Lucky Bill's, Fort Churchill, Twenty-six-Mile Desert, Eagle Ranch, and other settlements, as well as from the placer mines.

In 1857 the Mormon settlers were called back to Salt Lake by a messenger from the Prophet. Some fifty families left claims,

cabins, water ditches, and other property, loaded one hundred and fifty-three wagons, and were on the road in three weeks. A few years later one of them, the noted Orson Hyde, wrote to the possessors of a sawmill he had built, demanding its return, and adding: "This demand of ours remaining uncanceled shall be to the people of Carson and Wassau as was the ark of God among the Philistines. You shall be visited of the Lord of hosts with thunder and with earthquakes and with floods, with pestilence and with famine, until your names are not known among men." The letter was printed, and the camps of 1860 rang with loud laughter. But in 1857 no one could see anything amusing in the departure of the Mormons. Emigrant travel had ceased, traders had gone, villages were deserted, plows left in the furrows, cabin doors flung open. Even Gold Cañon placers were nearly exhausted. Everything seemed "played out."

The early miners of Nevada knew nothing of prospecting as a business. They were so thoughtless and ignorant that it never occurred to them to look for the source of the metal they were obtaining in Gold Cañon and other ravines that headed in Mount Davidson. The little gold they found became more and more alloyed with silver, so that its value decreased from nineteen dollars an ounce to twelve dollars. The camp of Johnstown in Gold Cañon, where they wintered, dwindled in size, and discouraged miners went to other districts. Meanwhile two prospectors of education and ability, the Grosh brothers, were secretly exploring the Washoe Mountains for silver. Their letters home prove that they found "a monster vein" and other good prospects, and they began to organize companies in the Atlantic States and in California to work these claims. But one brother died from an accident early in 1857; the other lost his life in the Sierra the following winter. The first knowledge of the Comstock perished with these two brave, thoughtful, reticent young prospectors.

All the men who aided in the discovery of the famous mines wintered in Johnstown in December, 1858. Among them was one Henry Thomas Paige Comstock, a curiously ignorant, credulous, and speculative miner, familiarly known as "Old Pancake." "My first recollection," he wrote, "is packing beaver traps; trapped all over Canada, Michigan, Indiana, and the Rocky Mountains." Comstock, "Old Virginia," Peter O'Riley, Pat McLaughlin, "Kentuck" Osborne, "Long John" Bishop, Manny Penrod, Sandy Bowers, and a few others had been more or less together. Sometimes they were in Gold Cañon, sometimes in Six Mile Cañon, sometimes crossing from the head of one to the head of the other, along the side of Mount Davidson, over the top of the Comstock ledge. In January, 1859, a streak of warm weather tempting

some of them out, Comstock, "Old Virginia," and several others found "surface diggings" near "Slippery Gulch." They named the place "Gold Hill," and, staking out claims, proceeded to work the decomposed outcroppings over Crown Point, Yellow Jacket, Belcher, Kentuck, and other great mines as yet undiscovered. From the time they started the rockers, using water from a spring close by, Gold Hill averaged twenty dollars a day to the man. June 1st, O'Riley and McLaughlin, whose claim in Six Mile Cañon paid only two or three dollars a day, suddenly cut into the rock on the surface of Ophir, at the north end of the Comstock, and began to take out gold at the rate of a thousand dollars a day. They had only been working a few hours when Comstock happened along, saw the value of the discovery, laid a general floating claim to a mythical stock ranch in the region, and fairly bluffed the good-natured discoverers into taking himself and Manny Penrod as equal partners. "Kentuck" Osborne afterward came in, and the five took up the original Ophir claim.

The miners in the region soon staked out claims around Gold Hill and Ophir. "Dutch Nick" started a saloon and restaurant in a tent. "Old Virginia" went on a spree one night and christened the north-end camp "Virginia City." Comstock bubbled with happiness, and flung his money broadcast. But a rancher from Truckee Meadows, visiting the camp, picked up some of the despised "blue stuff" from the waste heap of Ophir, and afterward gave it to Judge Walsh, of Grass Valley, California, with the remark that "over in Washoe the miners were throwing it away." An assayer reported it to be nearly pure silver. This happened about midnight, and before dawn Judge Walsh was miles on the road to Virginia City, while hundreds of other men were making ready to follow. The Truckee Meadows rancher paid no attention to the excitement he had caused, but went quietly back to his farm. When Judge Walsh reached the camp Comstock sold for $11,000, only $10 of which was paid down. McLaughlin soon sold for $3,500, Osborne for $7,000, Penrod for $3,000. Careless, ignorant, the first Comstockers were blown aside like leaves in a whirlwind. They spent their money and drifted off here and there, pursued by ill-fortune. McLaughlin was soon cooking for a gang of men at $40 a month; "Old Virginia," while on a spree in 1861, was thrown from a horse and killed; Comstock, who had parted with his interests exactly two months after the ledge was struck, branched out into financial and matrimonial ventures, spent every dollar, wandered over Idaho and Montana vainly looking for another fortune, and in 1870 committed suicide. Sandy Bowers, who was considered a millionaire, went to Europe with his wife "to see the queen," and "had money to throw at the birds." He built a costly stone man-

VIRGINIA CITY, NEVADA, LOOKING TOWARD THE DIVIDE, ETC., TO GOLD HILL.

sion in Washoe Valley before birds of prey obtained all his money. His widow, the "Washoe Seeress," made a living for years by curiously futile predictions regarding the stock market, and still reads the future for those who care to listen. One after another all the placer-mining Comstockers went down before the rush of silver seekers.

That rush was in many respects the most remarkable one that California ever had known. Decidedly the best account was written by J. Ross Browne, who made his Peep at Washoe a classic of early Nevada. Stirred, he says, by the shout of "Silver! silver! Acres of it! Miles of it!" he left San Francisco in March, 1860, and made his way to Placerville. Beyond this point there were no stages. The town was full of men anxious to cross the mountains, and "practicing for Washoe" in the saloons. Every sign bore Washoe in large letters. Pack trains were starting daily for the mines. No animal could be had for love or money. "Lodging accommodations" consisted of enough floor space on which to lie in one's blanket.

The next morning Browne started on foot. The muddy trail was literally lined with broken-down vehicles and goods of every description. He stopped at nightfall in "Dirty Mike's" shanty, in which the bar and the public bedroom were the chief features. The second day hundreds of persons were in sight along the trail—men with wheelbarrows, handcarts, donkeys, mules; gamblers on fancy mustangs, whisky peddlers, organ grinders, drovers, Mexicans. Rain, snow, and slush prevailed for miles before he reached the log cabins of Strawberry. There he slept on the floor with about forty other pilgrims, and had his stockings stolen, which "were above gold or silver in this foot-weary land." Three feet of snow in the morning, four hundred men in the camp, and provisions low; eight hard miles to the summit, nine more to Woodford's. Browne and several others tried the trail, but were forced to return to Strawberry. The next day he tried it alone. The trail was over old snow, honeycombed with holes hidden by the new snowfall; pack trains were floundering through and occasionally falling into the cañons. Wind and sleet all day; mud knee deep in Hope Valley; all in all a terrible day's experience. The fifth day Browne's course was along the Carson. He was so worn out that he could only cover about eighteen miles between sunrise and nine o'clock at night. The sixth day he arrived at Carson City, and took the stage for the mines.

Virginia City, as Ross Browne saw it in the spring of 1860, lay outspread on a slope of mountains, speckled with snow and sagebrush and mounds of upturned earth. The dwellings were rude board shanties; tents of blankets, sacks, old shirts, and canvas; huts of mud and rock, caves in the hillside, and hollow heaps

of brush. Piles of goods were scattered about in the rain and snow. A scathing wind, the "Washoe zephyr," tore the huts apart and filled the air with gravel. Crowds were gathered in open places, trading claims or fighting over them. Other crowds were drinking and gambling in the numerous saloons. Rough, unkempt, unwashed miners, speculators, bummers, thieves, cutthroats filled the raw, unsightly mining camp with horrible confusion. "In truth," says our artless adventurer, "there was much to confirm the foreboding with which I had entered the Devil's Gate."

In a short time the demands of the Washoe country developed a complete system of transportation over three great toll roads, the finest on the Pacific coast. Massive freight wagons, marking in every detail the utmost skill of California workers in wood and iron, carried all the supplies for Nevada. Bearded and weather-beaten freighters, who were also owners of their outfits, walked beside the great mule teams. Each freighter carried his rod of empire, a short hickory handle to which was attached a long, close-plaited whiplash as big as one's wrist at the swelling part. At first receiving twenty-five cents a pound for whatever was carried between Sacramento and Virginia City, and hauling a thousand pounds to the animal, the freighter in a year or so was able to move twenty-four tons besides the wagons, with a sixteen-mule team, at a cost of four cents a pound for the entire distance. It is said that there is not on record in courts or newspapers a single instance of the loss of goods in transit either by fraud, force, or carelessness during all the years of the Nevada freighter's glory.

One stage line carried twelve thousand passengers to Nevada in 1863. Schedule time in 1861 had been three days for the one hundred and sixty-two miles, but it was soon reduced to eighteen hours. Three wealthy mining operators were once taken from Virginia City to the steamboat wharf in Sacramento in twelve hours and twenty-three minutes. Old travelers still recall with pleasure the ride across the mountains on the Placerville route. Its most striking moment was when one first saw from the summit of the pass the hyacinthine waters of sealike Tahoe and the level desert. "The eastward-gazing grizzly bear," to quote from one of the stories written by an old Elko silver miner, the late Dr. Gally, "lifts his flexible nostril to sniff the odor of the arid waste, then slowly turns and prowls westward. There is a visible line eastward where two worlds appear to meet. Beyond is the great 'empire of Artemisia,' where gold and silver were married in the volcanic chambers of the awful past. One sees the land of Washoe outstretched from the mountain tops, with its browns and grays, its arid junipers and dull nut pines, its crags of lime-

stone, basalt, porphyry, granite, in naked barrenness. There, underfoot," writes Dr. Gally, "the world is dry, gray, silent. Overhead, during the long cloudless day, it is pale blue, dry, silent. All abroad it is gray or dark with mountain distance, and it is silent. Silence is everywhere. No roar of far-off torrents tumbling down the hills to jar the night air underneath the stars —the stars still are, but all the torrents have departed. At some lost period backward of all dates, the Great High Sheriff of the universe in open court has cried Silence and has been obeyed."

Into such a land the silver seekers came, and it claimed them for its own. Soil, climate, topography, environment, began to create the Nevada type, with its large freedom, its quick comprehension, its broadly humorous buoyancy, and similar characteristics that one finds abundantly illustrated in such books as Mark Twain's Roughing It and in the writings of a great group of younger newspaper men. "Desperate climatic humor" is what Dr. Gally calls it. Occasionally an old copy of an early Nevada newspaper turns up, fairly scintillating with wit and sarcasm, but for the most part the files have been destroyed in the great fires. Said brave old De Quille, companion reporter with Mark Twain on the Territorial Enterprise:

"I used to make the newspaper my notebook for years, and I thought what a book I could write some day out of that notebook; but now I don't know of a single file in existence."

Still there are gleams of the past in stray copies that have escaped the fires. Senator Stewart was the most prominent man on the Comstock in the days before Sharon, and the Gold Hill News, amazed at his audacity, once likened him to the Colossus of Rhodes—he was as large and contained as much brass. Mark Twain, in his forgotten Proceedings of the Third House, once burlesqued nearly every member of the Constitutional Convention of 1863. Larrowe, of Landor, for instance, was made to glorify the "nine sceptered and anointed quartz mills" of his district until the president ordered him to "hold his clatter" and drop Reese River quartz-mill statistics. Mr. Stewart, after a long speech on miners' taxes, was told: "Take your seat, Bill Stewart. I have been reporting and reporting that same infernal speech of yours for thirty days. . . . You and your bed-rock tunnels and your blighted miners' blasted hopes have gotten to be a sort of nightmare to me and I won't put up with it any longer." The wealth of material in this field would fill volumes instead of paragraphs.

Hardly had the first rich ore been taken from the Comstock when an age of litigation commenced. The early claims overlapped and were badly defined, some being taken up under placer rules, others as quartz claims, and all without accurate surveys. Mat-

ters went from bad to worse, as every one had access to the record book in the pioneer camp, and most of the prospectors changed their stakes and boundaries as often as seemed best. The most casual study of the Comstock region in 1860 reveals the wildest Walpurgis-night revels of conflicting claims of every size, shape, and age tumbling over each other three and four deep. Besides, the Virginia lode was parallel to the Comstock, and many lesser veins crossed it or ran near, thus giving rise to the great legal problem of the day, Was the Comstock one ledge or two ledges?

Then followed the famous mining cases that fill volume after volume of the Nevada reports—Savage against the Bowers Company, Chollar against Potosi (pronounced Potoseé by all old "Cōmstôckers"), Burning Moscow against Ophir, and others of

Flash-light of Drills in Nevada Mine.

equal interest. The total number of lawsuits for twelve mines during this period is 245, and 168 of these were "actions brought" to dispossess the claimants of ground that, under the single-ledge theory, belonged to the first locators. The direct cost of this litigation was $10,000,000, or one fifth of the entire product of the lode during the fighting period. Pitched battles occurred underground; mines were flooded with water or filled with smoke. Forts were built, armed men employed, and battles fought on disputed claims. Some of the best mining lawyers of America were trained in this age of litigation. Stewart, known as "Old Invincible," tireless in devotion to his clients, received $100,000 from Belcher and $30,000 as a single fee from Yellow Jacket. The reputation of the Territorial courts suffered, and some of the judges resigned under stress of public wrath. Lord, in his History of the Comstock, sums up the period from 1860 to 1865 with

the terse remark that "the Washoe bar at that time was hardly a nursery for tender consciences."

The first problem that troubled the miners in the midst of their lawsuits was how to handle the immense bodies of ore. To develop the various claims by means of the usual shafts, tunnels, drifts, cross-cuts, and other underground workings was unusually difficult. The vein matter of the great fissure varies from 100 feet to 1,500 feet in width. The whole body was once a seething mass of fire and steam. It still remains in many places so hot that the appliances of modern science hardly enable the miners to accomplish any work. The ledge first sloped west, became vertical at about 200 feet down, and then bent toward the east, thus necessitating a second and finally a third line of shafts. Machinery for pumping, for hoisting, for ventilating and lighting the depths of the mines, had to be constructed upon a larger scale than ever before attempted. As the ore bodies were opened they were found to be so wide that the timbering system failed entirely. A new method, known as the "Deidesheimer square sets," was invented, which is still in use in all large mines. It consists of short timbers mortised together in frames that can be built up to any height or width, like the adding of cells to a honeycomb. A few years later the mines siphoned water from the Sierras under a pressure of 1,720 feet. Incidentally the miners invented the V flume to carry lumber down the Sierra slopes. The annual supply of timber for the mines amounted by 1866 to 25,000,000 feet of lumber and 170,000 cords of fuel. The consumption of both increased steadily until in bonanza days 80,000,000 feet of lumber annually disappeared into the drifts and chambers and 250,000 cords of wood went up in smoke and flame.

Metallurgists, too, found endless study in the methods of reducing Comstock ore. Beginning with slow Mexican *arastras* and *patio* yards, adopting in 1860 California stamp mills, and modifying the amalgamating apparatus to save the silver, the modern "Washoe process" was finally adopted, though only after years of costly experiments. For a time every one went rainbow-chasing for something to perform impossible chemical feats. One pioneer mill man used to put strong decoctions of cedar and juniper bark into his amalgamation pans; others actually used sage-brush tea, it being argued that Nature had created the otherwise worthless shrub for the express purpose of getting the metal out of Nevada's mountains! Persons with secret processes overran the mining districts, each one with the whole trick contained in a little bottle in his vest pocket, ready for a consideration to pour a few drops into the amalgamating pan. San Francisco was ransacked for drugs to put into the batteries with the pulverized ore. Alum, saltpeter, borax, potash, all the acids obtainable, tobacco

enough for a "sheep-dip," a multitude of articles never before used by miners, such were some of the contents of the Nevada mill men's witch caldrons in the early sixties. "The object appeared to be," says an amused observer, "to physic the silver out of the rock."

Slowly, after immeasurable waste, crude methods gave way to better ones. Mills were built in Washoe Valley, in the cañons, and on the Comstock, but the greater number were along the Carson River, so as to be run by water power. No less than 76 mills, costing over $6,000,000 and carrying 1,200 stamps, were in operation before the end of 1861. Some of the mills of the period are still remembered for their extravagant construction. Gould and Curry built one on a terraced hill where the mine owners spent about $1,000,000 in picturesque and useless magnificence. After a few years, when their bonanza began to fail, it was found that the reduction of their ore was costing fifty dollars a ton. The machinery was thrown aside, and it required $600,000 to put the mill in working order again. Everywhere, through years of readjustment, mills were torn to pieces, rebuilt, enlarged, made to do better and better work, until the results produced when the great bonanza mines were running at full speed attracted the attention of mill men all over the world.

RUINS OF OLD MILL NEAR THE COMSTOCK.

What is known on the Comstock as the old group of bonanzas began comparatively near the surface. The yield of the diggings of 1859 had been about $100,000 for the entire lode. In 1860 it yielded in round numbers $2,000,000. After that the mines were developed so fast that by 1865 the output of Storey County, most of it from the Comstock, was $9,500,000. During twelve years after 1859 the product of all the Comstock mines was $145,000,000.

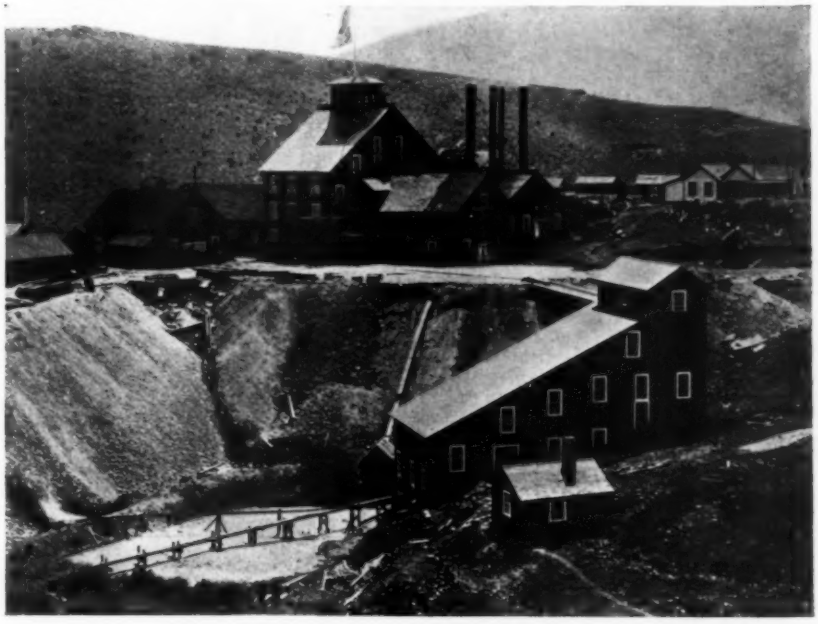
Work went on with increasing zeal. Mines that were in "*borrasca*," or barren rock, were kept going by immense assessments. If the present business methods that prevail in mining had been adopted on the Comstock, half of this enormous yield of $145,000,000 would have been clear profit, but the greater part of every bonanza went into running and extraordinary expenses. Reckless waste and superb enterprise seemed to go hand in hand. The numbers of relatives and friends that the owners of the mines managed to support by making positions for them can hardly be reckoned. Everybody, from servant girls to bankers, speculated in Comstocks and other mining shares.

In 1860 more than five thousand claims within thirty miles of Virginia City were "on the market." Frenzied prospectors were marking out thousands more, until the most remote corners of the desert were "pegged down with claim stakes" set on indications which were seldom attractive to a mineralogist. Iron pyrites and all sorts of worthless combinations seemed as good as gold or silver to the enterprising adventurers. Before long men were claiming to have found huge ledges of iridium, platinum, and plumbago. One Washoe speculator being told by a gentleman that an ambergris mine would be valuable, replied that he had just staked out one! A company tunneled for weeks into the granite of Mount Davidson in order to tap an alleged lake of coal oil.

No one can reckon up the number of prospect holes that dot Nevada. Millions of them, mere ragged cuts or pits in the tawny hillsides, make wind-blown heaps on every hand between the clumps of dark sagebrush and the dull yellow of an occasional sunflower. Only one prospect hole in a hundred ever materialized into a recorded claim; only one claim in a thousand ever became a mine. Up to 1880 Virginia City and Gold Hill alone had 16,000 registered claims, and less than a dozen really great mines. To sum it up, the amount of dead work and wasted capital in every mining region almost surpasses belief. Ruins of mills and dwellings, nameless graves in the canoñs, fragments of old trails washed by the storms of thirty winters, are all that mark the sites of many once-aspiring districts. In Esmeralda and White Pine, which the late Dr. DeGroot used to call "those Golgothas of Nevada speculators," what millions were fruitlessly scattered!

The entire history of the Comstock lode is revealed by the assessments, dividends, and fluctuations of the stocks of separate mines. Before the close of 1861 eighty-six companies were working on or near the great lode. Gould and Curry, a marvelously rich mine, declared $2,908,800 in dividends in 1863 and 1864. This was upon an actual investment of less than $200,000. But the ex-

penses of the mine, which worked 110,000 tons of ore during those two years, were nearly $6,000,000. It is believed that twice as much could easily have been paid in dividends, but, as the president of the company said, "every shareholder was crazy and wanted it snaked out at once at any cost." Gould and Curry, July 1, 1863, was selling at $6,300 per foot (the old way of measuring values); in July, 1864, it was worth only $900. Belcher was one of the dividend mines of the Comstock, having paid $16,000,000 up to 1880. It had 104,000 shares after 1869. In that year prices ranged from $12 to $35; in 1870, sank from $36 to $1; in January, 1871, rose to $6, and in December to $450; in Janu-



ALTA MINE, MILL, AND DUMP, GOLD HILL.

ary, 1872, sank to $6, and in April rose to $1,525, fluctuating all that summer down to $1.50, up to $95, and back and forth after this fashion for years. Once it rose in a month from 25 cents to $113 a share. Out of 103 Washoe mines listed, only six ever paid more money in dividends than they levied in assessments. These six were Consolidated Virginia, California, Belcher, Crown Point, Gould and Curry, and Kentuck. Some of the assessments levied upon mines that never paid a cent to the stockholders remain unparalleled in mining history. Ten mines sank nearly $17,000,000 before 1880. Assessments on Bullion were $3,352,000; on Overman, $3,162,800. Alta, Baltimore, Caledonia, Mexico, Imperial—these and other non-producers are still remembered with sorrow by thousands of investors.

Nevertheless, viewed as a whole, the Comstock was immensely profitable. In twenty-one years from the summer of 1859, according to Government reports, the mines levied in assessments $62,000,000. The dividends paid during the same period aggregated $118,000,000. Striking a cash balance, the Comstock ledger shows an actual profit of $56,000,000. The total bullion yield for the same period was $306,000,000. Subtracting dividends and adding assessments, we find that the cost of purchasing, maintaining, defending, and developing the great lode for twenty-one years was $250,000,000. Three fourths of this sum came from the mines themselves, the other fourth was gathered from direct assessments. The prospectors and original locators had received less than $100,000. The various owners paid less than a million dollars out of their own pockets, as working capital, before assessments and the stock-gambling period began. Since 1880 the yield of the Comstock has been decreasing, and many of the mines have been shut down. The ledger account of the Comstock with the public remains practically unchanged.

The most dramatic events in the story of the Comstock cluster about a series of struggles for its control during the ebb and flow of alternate borrasca and bonanza. Nothing was lacking to make the period impressive. The financial leaders of the Pacific coast were conquering Nevada, while another group of men were winning victories that shortly led to the culminating treasure of the lode, and while the indomitable Sutro was toiling in his great tunnel. So vast and ruthless was the battle that its far-reaching results still influence politics and social life of California and Nevada; men still divide upon issues which began in the depths of the Comstock a quarter of a century ago.

In 1864 the ore deposits were worked out, and rayless gloom settled over the Comstock. The Bank of California, through its resident agent, William Sharon, had been making advances on mills and allowing the mine owners to overdraw their accounts. The security in both cases was only undiscovered ore, and if the lode were really exhausted the whole camp was ruined. Ralston, the head of the bank, visited Virginia City in 1865, and agreed with Sharon that the time had arrived to gain control of the district. Loans, instead of being lessened, were increased, to what extent is not known, but it was afterward said by Sharon that at one time before 1870 $3,000,000 of the $5,000,000 capital of the bank was on the Comstock. In June, 1867, the famous mill and mining company was formed by W. C. Ralston, William Sharon, Alvinza Hayward, D. O. Mills, Thomas Bell, Charles Bonner, William E. Barron, and Thomas Sunderland. It was the strongest possible combination of capitalists and mining men; its business was to manage the mills and mines that had now fallen into the

hands of the Bank of California through foreclosure and through manipulations of stock. It also aimed at securing control of others, and ultimately at directing the output of the entire lode.

There are, let me explain, two systems of handling ores. A mine can own its mills, or it can send to a custom mill. On the Comstock the mine-owners' experiments in building mills had proved disastrous. The independent millman was a more efficient ore-worker than a salaried superintendent. But the Comstock system did not secure the permanent welfare of the outsiders. What Prof. Raymond calls "the piratical policy of gutting the mines" was carried on in bonanza times at such a shocking rate of speed that it unduly stimulated the building of more mills, and then left the mines totally unable to sustain any of them. It is not surprising that the Union Mill and Mining syndicate were soon able to gather in seventeen of the leading mills and to keep them running on ore, while outside mills could not make a living. It became evident that the substitution of Sharon for Stewart as the leading personal force on the Comstock was in reality the most complete revolution the sagebrush land had yet known.

Nevada had long "talked railroad." Legislatures, Territorial and State, had granted many charters, but after a few abortive efforts the last of these haphazard schemes was dead. Sharon, the man of affairs, sent for James, of the Sierra Nevada Mine. The following conversation is said to have occurred:

"Can you run a railroad from Virginia City to the Carson River?"

"Yes."

"Do it at once."

Within thirty days the winding course, twenty-one miles long, was surveyed; graders were at work; rails were on the way; men were hewing ties in the Sierras; an obedient Legislature had passed a new charter and had authorized $500,000 in bonds as a bonus to the road; lastly, the mines had subscribed $700,000. It was a busy month, even on the Comstock. Extended to a junction of the Southern Pacific at Reno, the Virginia and Truckee Railroad cost about $3,500,000. The maximum grade is 116 feet to the mile; the curves of the track in the thirteen miles and a half of mountain distance make seventeen full circles, and the rise is 1,600 feet.

Sharon had put Chinese graders at work, but the miners' unions of Gold Hill and Virginia City marched out a thousand strong. The sheriff halted them, and they sat down on the rocks to hear him read the riot act. That ended, they rose with shouts of Homeric laughter, gave three cheers for the sheriff, and moved resistlessly on the graders' camps. The Chinese "ran like rabbits" up the gulches. The miners told the boss to quit work, and,

marching back, sent word to Sharon that no Chinamen would be allowed in the district under penalty of a strike that would shut down every mine on the lode. In twenty-four hours the Chinese were dismissed and white graders took their places. Defeated here, Sharon silently made ready for the real labor conflict that he foresaw. It began when the first trains entered Virginia City. The fine old silver freighter, in Nevada slang the "mule skinner"; the bull-puncher walking sedately beside his oxen; even that aristocrat of the fraternity, the lordly "silk-popper," flicking his playful whiplash at the leaders as he drove his stage-coach down Geiger's grade—these, all these, after fierce, useless struggles, disappeared into the unrailroaded distance. "Sharon's iron mules," as they said, "had crowded them off."

Meanwhile the total bullion yield of the lode, which was $16,000,000 in 1865, continued to decrease till in 1869 it was only $7,500,000. None knew better than Sharon and his associates that although borrasca had put them into possession, a few more years of borrasca would utterly smash their fortunes. There had been in all eleven bonanzas up to 1869, but now all were "worked out," and the ordinary ore in the mines not only grew poorer and scantier on the lower levels, but was harder to work. Everything was in eclipse. The miners were following a mere stringer of ore on the nine-hundred foot level of Yellow Jacket that gave Sharon a little hope, but troubles with the miners and disastrous fires intensified the situation. By 1870 some of the members of the syndicate began to weaken; it was openly said that the Comstock had paid its last dividend; the cities of the lode were trembling on the verge of panic.

The famous John P. Jones, since United States Senator, was superintendent at Crown Point, and, like all the rest, was vainly looking for ore. The stock fell to two dollars a share, making the total value of the mine, with its costly plant, only $24,000, and assessments went unpaid. Late in 1870 Jones found an ore body, and, joining forces with a discontented member of the bank syndicate, wrested control of the mine from Sharon before he knew of the bonanza, which in eighteen months more raised the stock-market value of Crown Point to $22,000,000. They also organized the Nevada Mill and Mining Company in direct opposition to their old associates. Nevertheless, Sharon's lesser defeat only emphasized a greater victory. His interests in other mines doubled and quadrupled in value, empty treasuries were filled by outside investors, and search for new ore bodies was prosecuted with renewed energy.

The story of the rise of Mackay and Fair reads like a leaf from the Arabian Nights. Like Jones, they had been poor and unknown, working for daily wages. Associated with Flood and

O'Brien, they discovered the Big Bonanza, the richest treasure of the Comstock. Mackay outranks the rest of the group, because his rise was more remarkable and his grasp of circumstances more firm. From toiling in the lower levels he rose to be superintendent of one of the smaller Gold Hill mines. Like Fair, he saved every dollar and put it into stocks under his own control. Before long he was interested in "Kentuck," a rich little mine, and it began to pay dividends again. His own statement is that for years he had labored with all the powers of mind and body to make himself "master and manager of the greatest mines in the world." Kentuck gave him the start. Mackay and Fair, now associated in every enterprise, ventured to make a fight for the control of Hale and Norcross, which they acquired in March, 1869, its stock, like everything else on the lode, being greatly depressed. Fair, leaving Ophir, of which he had long been superintendent, soon put Hale and Norcross on the dividend list. Old Comstockers still praise "Uncle Jimmy's fine nose for ore." The mining skill of Fair, as well as of Mackay, rose at times into the domains of genius. Before the close of 1869 they controlled Savage and Bullion. This proved a bad affair, and nearly ruined them. The Bank of California millionaires began to feel relieved in mind. In a year or two, they said, Mackay will be back in the face of a drift, at four dollars a day, and Fair can be made useful somewhere on a superintendent's salary. But the Mackay firm, still convinced of the reasonableness of their system of exploration, concentrated their last resources upon a long-neglected portion of the lode.

The Comstock mines begin at the north with Sierra Nevada, 3,300 feet on the lode; coming south, Union Consolidated follows, 600 feet; then Mexican, the same size; then Ophir, 675 feet. All these were being worked on a large scale. Next came a group of small neglected claims whose titles were in dispute, 1,310 feet in all, followed by Best and Belcher, Gould and Curry, Savage, and Hale and Norcross, which completed the famous north-end, or Virginia City, group of mines. The neglected section, 600 feet of which was afterward known as California, and 710 feet as Consolidated Virginia, was worth only $40,000 on the stock market. As Mackay and his associates bought, the stock rose; the three-fourths interest they desired cost $100,000. They took control in January, 1871, and began mining operations, sinking a new and large shaft and pushing a drift north from Gould and Curry, nearly 1,200 feet below the surface, by a special contract with the owners of the mines crossed.

One day Fair discovered a slight change in the barren rock and determined to follow a narrow seam hardly thicker than a knife blade. Sometimes it was only a film of clay, but occasion-

ally a pin point of ore was seen. For hundreds of feet the miners drifted beside this slender clew. Fair became ill, and the workmen lost it, but on his return he picked up the ore thread. They were now a hundred feet in Consolidated Virginia ground, and the price of the stock began to break, when suddenly the stringer widened to a vein of sixty-dollar ore. In October, on the 1,167-foot level, the top of the "Big Bonanza" was uncovered; the drift went 148 feet through solid ore 54 feet wide. The great kidney-shaped mass extended downward below the 1,500-foot level, and widened to 150 feet and even to 300 feet. The ore grew

GOULD AND CURRY MINERS READY FOR WORK.

richer and richer as the men advanced. Nothing like it had ever been known in the history of mining.

Here, in the heart of the Comstock, hundreds of naked miners were soon hewing down the ore. On all sides of a pyramidal mass of timber which grew larger every minute were twinkling stars of lamps. Everything in the bonanza was sent to the mill as fast as it was quarried out, and some of it was so rich that waste rock was added to aid amalgamation. An average block of ore three feet square contained from two hundred to five hundred dollars in silver and gold. The richest spot was near the California line, where clusters of malleable silver in coiled wires occurred beside shining stephanite, pale-green and steel-gray chlorides, and lustrous black silver glance, besides masses of the most exquisite crystals of every color known to the mineralogist.

In six years Consolidated Virginia milled 682,355 tons of ore, producing $60,732,882; California, in four years, milled 486,043 tons, producing $43,727,837. The total yield of the Big Bonanza had been nearly $105,000,000, and more than $73,000,000 had been

paid in dividends. Extreme haste was necessary in extracting the ore, so great was the danger of a disaster. Mackay and Fair hardly rested day or night till the bonanza was exhausted. Outside, all the exchanges of the world were fighting over Comstocks. The two mines, rated in 1871 at $40,000, were rated in 1875 at $160,000,000. Thirty mines on the lode were now valued at about $400,000,000. So much money was withdrawn from legitimate business and flung into the stock market that when the inevitable crash came and the Bank of California failed, every industry of the Pacific coast was checked for years.

In the midst of the bonanza excitement Virginia City was swept by a great fire, the culmination of a long series of mining disasters, and in a few hours a territory half a mile square was a mass of ruins. The mining companies lost acres of supplies and lumber; Ophir, Consolidated Virginia, and California had all their buildings burned; two thousand stores, hotels, lodging houses, and dwellings were destroyed. The very next day men were at work in the ruins, on the rugged hillsides, in the ravines, by the monstrous waste dumps, clearing away, rebuilding on a still more massive scale the giant machine shops, hoisting works, and mills. The two bonanza mines lost $1,500,000, and yet they managed to keep up regular dividends at the rate of $1,080,000 a month!

ADOLPH SUTRO.

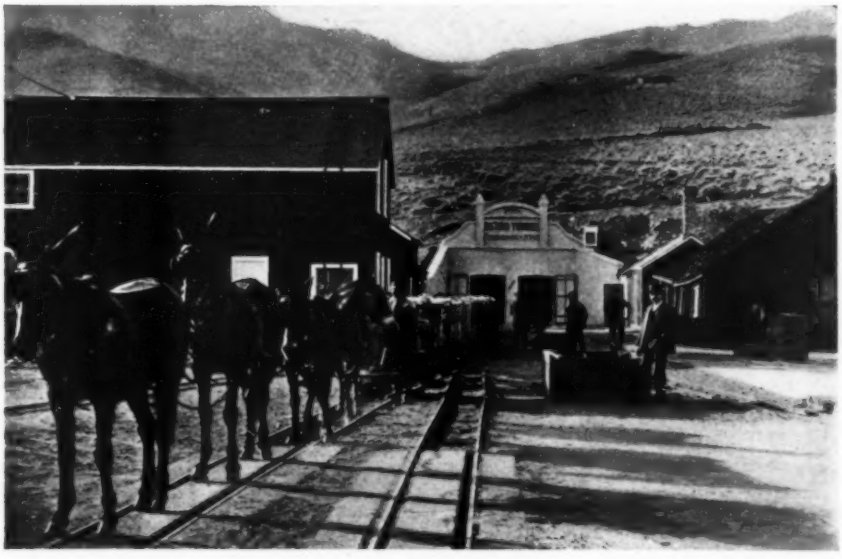
All these years one indomitable mill owner and engineer, Adolph Sutro, had been fighting single-handed the men who controlled the Comstock. Away back in 1860 he had advised a deep adit, and in 1865 he obtained a franchise for the Sutro Tunnel Company, with Senator Stewart as president. The mining companies bound themselves to pay perpetual royalties after the completion of the tunnel. Congress, assuming the regulation of the immense mining interests involved, passed an act which, still further protecting the enterprise, made the very titles of the mining companies dependent upon the fulfillment of their obligations. Large subscriptions were made, and

it was expected that the bonds would sell readily. But early in 1867 the Bank of California syndicate began to perceive that the Sutro Tunnel, delivering ore at the Carson River mills and mining supplies nearly two thousand feet below the surface, might very easily destroy their control of the Comstock and its dependent industries. Therefore they declared war, and opened hostilities. Stewart resigned; subscriptions were all withdrawn; shrewd lawyers and politicians were employed to obtain the repeal of the franchise and of the act of Congress; financiers in New York and Europe were warned not to touch Sutro bonds.

Years after Sutro said in conversation: "Ah, it was a hard thing to have so many old friends in San Francisco and Virginia City actually afraid to be seen talking to me after the fiat had gone forth that I must be crushed at any cost. But I kept on fighting. There was one time, I remember, when I had to go to Washington to save my interests from destruction. I had no money. All the profits of my mill had been swallowed up. But I had a lot in a little California town, and I sold it for two hundred dollars, and with that I managed to get to Washington. I stayed there somehow that winter, poor as I was, and fought my enemies, and came out ahead. But their newspapers said I had bribed Congress—out of my two hundred dollars!"

After making the most strenuous efforts Sutro failed to place his bonds. In 1869, turning for help to the working miners, he delivered a remarkable address in Virginia City. Large cartoons illustrated his bitter eloquence. One showed Bill Sharon's Big Woodpile, another Bill Sharon's Crooked Railroad, a third the then recent fire in Yellow Jacket, where forty-two lives had been lost that might have been saved had the Sutro Tunnel existed. He appealed to the miners' unions for stock subscriptions with which to begin work. "Will the people of Nevada see me crushed out now? . . . Come in together. Let two thousand laboring men pay in ten dollars apiece a month, and insure the construction of the tunnel, carrying with it the control of the mines. . . . From dependents you will be masters." With such sentences he addressed the working miners of the Comstock, who actually raised fifty thousand dollars in a few weeks, and on October 19th resolute Sutro broke ground in his great undertaking. Nevertheless the tunnel was steadily opposed by the California and Nevada Senators and by nearly all the mining men on the Comstock. The history of the long struggle is embalmed in the pages of the Congressional Record and innumerable public documents. Sutro bonds were finally sold, but the difficulties of the undertaking proved greater than had been expected, and the period of the bonanzas passed before the lode was reached.

The progress of the work was dramatic. The face of the rock "showed a temperature of 114°." Two or three hours was all that the strongest men could work. Endurance was strained to its utmost capacity. Man after man dropped down on the rocky floor and was carried to the surface babbling and incoherent. This strenuous toil continued till July 8, 1878, when Sutro himself, half naked like one of his miners, labored at the front, and finally crawled through a jagged hole into the Savage drift, "overcome with excitement," as one of the newspaper accounts



SUTRO TUNNEL, SUTRO, NEVADA.

said. What had been contemptuously called "Sutro's coyote hole" thus became an accomplished fact.

Through such passionate conflicts as those described the heroes of the Comstock continued making workshops, mills, machinery; building two marvelously picturesque towns along the lode, and hiding underneath the greater creation—the real City of the Comstock. Here, in deeps below deeps, are three-mile streets, mysterious labyrinths, water torrents, burning heats, perils numberless, legends that might serve to fill a volume. Time was when twelve thousand miners toiled in these vast galleries, swinging picks, hammering drills, raising timbers to place, climbing to the stopes, breaking down the ore, pushing lines of loaded cars to stations on the hoisting shafts. They were superb athletes, with muscles evenly developed by their labor. A few of them remain, scraping out the ore left in older workings and maintaining to the fullest degree the fine old-time pride of their craft. For sixteen years, however, the mines have been

in borrasca, and they may never again pay a profit to their owners. Still, with faith and endurance that are sublime, the heroes of the Comstock cling to its fallen fortunes, and continue the search for new bonanzas.

[EDITORIAL NOTE.—The full story of the mines, as illustrated by the great Comstock lode, prepared by Mr. Shinn, will constitute the next volume of the Story of the West Series, edited by Mr. Ripley Hitchcock, to be published by D. Appleton & Co. in October. Our readers need hardly be told that Mr Shinn has special qualifications in his familiar acquaintance with the subject and his rare literary skill, which will impart special interest and value to this work]

A MEASURE OF MENTAL CAPACITY.

BY DR. EMIL KRAEPELIN,
PROFESSOR OF PSYCHIATRY AT HEIDELBERG.

(From an Address delivered in behalf of the Heidelberger Frauenverein.)

WE are able to calculate almost precisely the amount of work any given machine—as a steam engine or an electric-lighting plant—is capable of performing, and the amount of fuel that will be required to develop the calculated power. When we come to man we are much less certain, although a skillful army surgeon can tell almost at a glance whether the recruit standing before him is strong enough to meet the requirements of the service, and there are machines in the market that will inform us in what time we can pull a given weight to a given height. But we have no measure that we can apply to the capacity for mental work, and no units of mental valuation. The most we can do is to compare the intellectual capacity of one man with that of another by the mental results they have severally achieved in practice. When we wish to test the fitness of a candidate for a position of trust or responsibility, we subject him to an examination, which relates, however, mostly to what he has learned, and from which we guess in a rather indirect way what he may be capable of doing in the future, and with relation to other matters than those on which we examine him; and the test is very often deceptive: for those who have made the most brilliant displays in the examination frequently fail in capacity to make practical application of what they have learned only theoretically; or they fail by irregularity, frequent and marked changes in their disposition to work, want of endurance, or too great dependence on external conditions, of which the examination gives no prediction. Such efforts as have been made to obviate this difficulty have hitherto failed to meet their object.

It has, however, recently become possible to reach fairly approximate conclusions concerning mental capacity, such as other-

wise even a long personal acquaintance with the candidate could not afford, and to determine with considerable exactness the working power of individuals in simple mental tasks. The measure is afforded by determining the number of small, similar problems resolved by the subject in a given time—such, for example, as numbering letters, reading, the learning by heart of series of numbers or syllables, and the continuous addition of columns of numbers. In the last-mentioned method the person under trial is set to adding figures ranged one under another in a book printed expressly for that purpose, for a considerable time, without stopping—under some circumstances, for several hours. When the sum reaches a hundred, the hundred is simply carried on and added to the excess in units. A bell sounds every five minutes, when the candidate draws a line after the last-added number. At the end of the trial it is easy to determine how many numbers the person can add every five minutes.

The candidates—all of nearly equal degrees of advancement, and of about the same age—varied greatly in the speed of their execution, the more rapid ones adding two and a half times as many numbers in five minutes as the slower ones. This proves that facility in reckoning is largely peculiar to the individual. Accuracy, however, was not considered. If that had been brought in, some of the results might have been materially different.

It further appeared that the speed of the additions increased regularly with each effort, but not equally with the different subjects, so that it was possible sometimes for a slower calculator eventually to pass ahead of the next quicker one. This improvement in facility was, however, subject to limitation, and is less in each repetition—as, for example, twenty-five per cent from the first trial to the second; fifteen per cent from the second to the third; and about six per cent from the third to the fourth—till a point is finally reached when there is no further increase. This capacity for improvement through practice appears also to be an individual quality. The permanence of the acquisitions obtained through it has not been sufficiently investigated; but they seem in the end gradually to wear out, and the rapidity of the wearing-out process to vary with the persons.

Of an opposite character to this is the far more rapidly increasing effect of fatigue, which always causes a diminution of efficiency, however much it may at first be temporarily balanced by the improvement through exercise. When it has once gained the upper hand, a speedy and unintermitted decline of efficiency ensues. The time when this shall take place depends on the degree of capacity already reached, the personal peculiarity, and casual influences.

The differences in the susceptibility of different persons to fatigue are very interesting. Every person, as a rule, possesses a course of efficiency peculiar to him, which works itself out in the same manner during any particular period of labor. Some display in single efforts first an increase and then after some time a decrease of efficiency; they are least readily fatigued. Others, registering a depression of efficiency after the first quarter of an hour, betray a very great susceptibility to fatigue. All the transitions are observable between these two forms, but each individual generally follows the same course according to his personal peculiarity.

The susceptibility to fatigue is observed in all possible examination tasks, and may therefore be considered to represent a bottom principle of the individual personality, which, while it may be influenced within certain limits, as a general rule measurably determines the capacity of men for work.

Other means of measuring the capacity of a subject are afforded by the ease with which he is diverted from his task, or his susceptibility to disturbing influences from without and from within; his elasticity, or the readiness with which he recovers from the effects of fatigue or diversion; and the way he is affected by taking food, physical exercise, and the time he has for sleep. In each and all of these fields of inquiry the result obtained has to be complemented finally by the estimation of the qualitative value of the work accomplished.

We may infer from this passing review that it is actually possible to express important properties of mental personality in measurable, generally comparable, determinations. But we are still far from being able to apply such measurements to the purposes of daily life. Yet, while we fail if we attempt to draw certain lessons from the matured, complicated organization of the grown-up man, the simpler, still growing mental equipment of the child affords a more fruitful field for study and is more subject to our influence.

The question then presents itself for investigation of the mental endurance of our school children. The school requires its pupils to perform daily a specified amount of mental work, while it is really not clearly known whether the childish brain is actually able to fulfill the demand without suffering lasting damage. The young men I experimented upon, whose facility in addition fell off at the beginning of the second hour, had already had their working powers exercised and tested by responding to the demand of the school and of the university. Against them was a child two years old, who gave plain evidences of weariness after only a few minutes of fixed attention. Valuable researches on this subject have been made by Prof. Burgerstein, of Vienna, who com-

posed four series of problems in addition and multiplication, the written solution of each of which would require at least ten minutes. He gave them, mostly during the earlier school hours, to pupils of different classes, between eleven and thirteen years of age, so that the pupils would have to make four calculations ten minutes long. Five minutes' pause was given between each problem and the next. The whole experiment thus lasted fifty-five minutes, or about the usual length of a school hour. One hundred and sixty-two pupils took part in the exercises, and the results were so nearly uniform that their trustworthiness can not be doubted. The first result was a notable increase of facility in the several sections of the experiment. The number of numbers counted up was about forty per cent larger in the last section than in the first. It was found, however, that not all the pupils shared equally in this advance, but that about forty-three per cent of them showed an evident sinking of efficiency at the end of the hour. The differences in personal susceptibility to fatigue previously observed among adults was also expressed here. This, however, is only a small part of the real results of the experiment. Prof. Burgerstein took pains to determine the number of mistakes committed by the pupils and the corrections they made, in order to estimate the value of the work accomplished in the several sections. Both appeared to increase from the very first, and much more rapidly than the speed of the work. It follows hence incontestably that the evidences of fatigue in the children under examination make themselves evident with increasing force from the second section of the experiment, and that in the majority of the children it is only outwardly concealed by the likewise increasing skill. The quantity of work rose, but its value underwent a constant depreciation. Similar results were obtained by the Russian Sikorski from dictation exercises, and by Höpfner in Berlin from dictations to boys nine years old.

The general result of these still too limited investigations of the susceptibility of school children to fatigue is the incontestable fact that the demands which the schools make upon the mental capacity of their pupils are far in excess of what they should be.

Yet this work is never continuous, but is interrupted by numerous pauses for rest, which doubtless have considerable influence on the progress of fatigue. The results of Burgerstein and Höpfner's experiments would have been much more unsatisfactory if brief pauses had not been interpolated between the different working spells. The remarkable fact was brought out in my experiments with adults in addition, in which pauses of ten minutes were interposed between the half-hour tasks, that the efficiency immediately after each pause was much higher than at any time before. This result is explained simply by the different velocities

with which the influence of practice and that of fatigue are lost. Fatigue passes away, comparatively very quickly, while the gain from practice, as already mentioned, is plainly demonstrable after weeks and even months. Thus it happens that with intervals of days or weeks each succeeding series of experiments begins with a quickness in calculation which is much greater than the highest achievement of the former experiment. The same takes place likewise after the short breathing pauses, as long as these pauses are sufficient to overcome in a measure the fatigue that has begun.

Since through the interpolation of pauses from work the otherwise inevitably sinking efficiency is kept at a nearly even height, the length of the periods of rest ought to be so adjusted that the injurious effects of fatigue should never acquire a predominance over the facility acquired by practice. If the experiment, however, is carried too far, the short pauses will no longer counterbalance the effect of fatigue, and the capacity to work will become null. For this reason the resting spells, if they are really to accomplish their purpose, should not only be much larger than they are now in our schools, but should succeed one another at shorter intervals and should be increased as the teaching is protracted.

The picture which we have to compose on the basis of the experiments under consideration is a gloomy one. While a quarter of an hour of simple work is enough to develop the first signs of fatigue in a twelve-year-old pupil, lessons of several hours' duration, interrupted only by a few short pauses, should soon lead to complete mental exhaustion. The demand on attention is much too long, the breathing spells are much too short, for healthy efficiency to be maintained only remotely.

The picture is, however, too darkly drawn. What I have sketched could take place only if the schools attained what they are striving for with all their means. Kind Nature has provided a safety valve for the salvation of our growing youth, the value of which can not be too highly estimated—inattention. Only by effort, and only for a short time, can we force a measurable concentration of the full force of attention upon the solution of the problem; care is therefore always taken in the school that the time of the session shall not be regarded wholly as a time of work. Burgerstein, indeed, thought that through the pauses he introduced the relation between effort and relaxation might be imitated in a regulated school hour. But these experiments seem to me to show to a certainty that our children would necessarily fall into mental disorder if they were really forced to work with full attention for forty minutes in each school hour. That, in fact, only a few are seriously injured by overwork in school is due to those interruptions to study and those incidents in teach-

ing that give the pupils happy opportunities to loosen the reins of their tired attention and forget the hard present. "One can compel children to sit and be still," says Burgerstein, "but he must not mistake; they will still in many cases take mental rest, or make a change for themselves, and not follow the course of the teaching if they are tired." Hence arises the unexpected consequence that, under the present extension of instruction, tedious teachers are a necessity.

To a certain extent the dangers of mental overwork have been recognized for a long time. All those efforts to introduce physical exercises into the school hours have in view, to a greater or less extent, the defense of the childish brain against the imminent dangers of a one-sided tension by alternating mental and muscular exertion. Gymnastic and movement exercises, manual training, and singing and drawing, to a certain extent, are intended to furnish rest-pauses for recovery from mental weariness and the gradual restoration of the previous efficiency. For this purpose such have been interposed at intervals to relieve the strictly mental work.

The physical exercises are doubtless of considerable value toward the complete building up of the personality, but they must be regarded as relaxations only within certain limits. It is, at any rate, fundamentally false to regard physical effort as in any way a suitable preparation for mental labor. Protracted experiments, pursued under my direction, have given the result that a simple walk of from one to two hours diminishes the mental efficiency in adults at least as much as about an hour's work in addition. The same is the case to a more limited extent with much less important bodily efforts. It is well known to pupils and teachers that the greater the interval of active play, the longer time is required for collecting the faculties before returning to mental work. From these experiments has arisen the demand that physical exercises should not be regarded in the plan of teaching as relaxations; and the demand for hard mental work should not be imposed on the pupil till after a rest from them.

By far the most important compensation for all effects of fatigue is sleep. Everybody, even the man mentally most inert, develops when awake a mass of mental effort which he can not afford continuously without suffering. We need, therefore, regularly recurring periods in which the consumption of mental force shall be slower than the continuous replacement. The lower the degree to which the activity of the brain sinks, then, the more rapid and more complete the recovery.

The mental vigor of most men is usually maintained at a certain height for the longest time in the forenoon. The evidences of fatigue come on later at this time of day than in the evening,

when the store of force in our brain has been already considerably drawn upon by the whole day's work. If no recovery by sleep is enjoyed, or it is imperfect, the consequences will invariably make themselves evident the next day in a depression of mental vigor as well as in a rise in the personal susceptibility to fatigue. The rapidity with which one of the persons I experimented upon could perform his tasks in addition sank about a third after a night journey by railway with insufficient sleep. Another experimenter could detect the effects of keeping himself awake all night in a gradual decrease of vigor lasting through four days. This observation was all the more surprising, because the subject was not conscious of the long duration of the disturbance, and was first made aware of it incidentally by the results of continued measurements on the causes of the manifestations of fatigue.

These experiments admonish us to give special attention to the question of sleep with men who work with their minds. This is of more especial importance for the growing generation, because the susceptibility to fatigue, and consequently the need of sleep, are much greater in the youthful brain than in that of adults. The average duration of sleep has been studied by Axel Key in Swedish pupils of different ages. He found that it ranges from nine hours in children ten years old down to seven hours in pupils of eighteen years. Children ten years old were found who slept only six, and some of seventeen or eighteen years who had to satisfy themselves with four hours!—a result which is really astonishing. Axel Key is certainly right when he assumes that the mass of Swedish school children of all ages are daily deprived of one or two hours of their needed sleep, to say nothing of those unfortunate ones who can sleep only half the time or less which is required for their healthy mental and bodily development.

The amounts of sleep required by different men are very various, for they are dependent on the deepness of the slumber. There are persons who sleep so soundly that a surprisingly short time spent in sleeping is enough for them. On the other hand, we know that for many idiosyncrasies a length of sleep which is quite enough for the average of men is much too short.

Besides sleep, which limits the waste for a certain time and favors the restoration of what has been consumed, we need for the maintenance of our working strength the assimilation of food. By means of food the substances are introduced to the tissues which they require for their constant renewal. Sleep alone can indeed retard for a long time the continued destruction of the organs by the processes of life, as it does in the hibernation of animals; but there comes a point at last when only the introduction of fresh restorative matter can assure the continued main-

tenance of the body. This necessity comes more speedily upon workingmen than on men of leisure, earlier upon children than upon mature persons. An infant at the breast could be entirely deprived of food for only a short time without serious harm, while a sound man, with other conditions favorable, can bear a privation of several days.

A time of several hours passes between the taking of food and its complete utilization in the body. During this time, especially after hearty meals, the mental vigor is diminished in a marked degree. Later it gradually rises, and the susceptibility to fatigue diminishes.

When now we look back at the conditions we have discovered that control mental vigor, we conclude that our children are exposed by the extent and arrangement of study-work in the schools to great perils for their mental and physical development. The questions that press upon us on this matter are of such importance that we all have reason to give them our full, undivided attention. We are only at the beginning of a real hygiene of mental labor, but the results we have obtained in this research, fully indicating the nature and operation of the dangers, point with equal clearness to the character of the preventive and remedial measures which should be sought and applied.

SOME BEGINNINGS IN SCIENCE.

By Prof. COLLIER COBB.

LONG before the sciences were pressing their claim to equal rank with ancient learning at Harvard, before Jefferson had seen the establishment of the University of Virginia working under the system of elective studies which he had planned, or before the magnificently endowed institutions of technology were giving what Herbert Spencer regards as knowledge of most worth, we find the beginnings of these things in the newly established university of a State that could boast of only two schools which taught more than the three R's and the very rudiments of the English language.

This modern plan of instruction offered by the University of North Carolina more than one hundred years ago was the work of a committee of six. Two of this committee were graduates of Princeton, one a graduate and ex-professor of the University of Pennsylvania, two had been students of Harvard, but their education at Cambridge had been interrupted by the Revolutionary War, and the sixth was an eminent lawyer. The names of these men were Samuel McCorkle, David Stone, Alfred Moore, Samuel

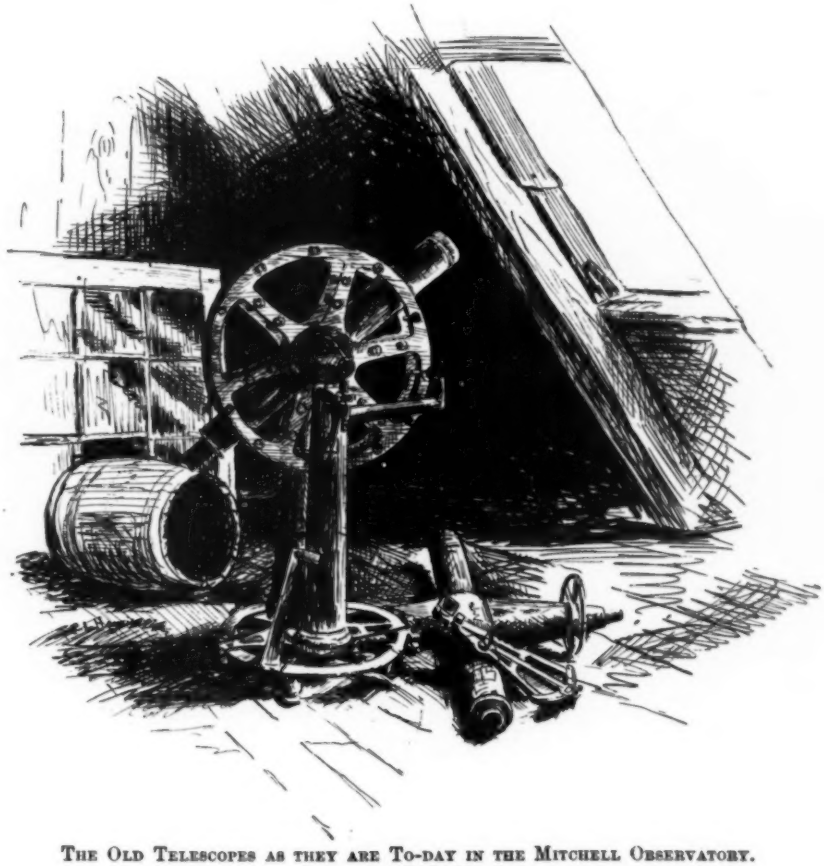
Ashe, Hugh Williamson, and John Hay. The course planned by this committee in 1792 gave great prominence to the scientific studies, especially those which could be applied to the arts. The report further recommended the purchase of apparatus for experimental philosophy and astronomy, in which must be included a set of globes, barometer, thermometer, microscope, telescope, quadrant, prismatic glass, electrical machine, and an air-pump. The ancient classics were made elective, the degree of Bachelor of Arts being obtainable without the study of either Latin or Greek. In 1800, however, Latin was made a required study, and an election allowed between French and Greek; and in 1804 Greek was added to the required studies. It is remarkable that this scheme, adopted in 1792, is almost identical with that adopted by Congress for the colleges to be formed under what is known as the Agricultural and Mechanical College Land Act of 1862. But its interest for us to-day lies in the fact that it led to the establishment of the first astronomical observatory in the United States, to the first geological survey by public authority in America, and to the first equipment for the teaching of electricity.

JOSEPH CALDWELL.
From the collection of Hon. Kemp P. Battle.

The men chosen by the trustees to begin this work were David Ker, a graduate of Trinity College, Dublin; Charles W. Harriss, a Princeton man of the class of 1789, Professor of Mathematics; and Samuel A. Holmes, also an alumnus of Princeton. Mr. Harriss was succeeded in his professorship by Joseph Caldwell, Princeton, 1791, who was a tutor at Princeton at the time of his appointment to the professorship in North Carolina.

To Dr. Caldwell we owe the realization of the hopes of the original committee, the ultimate establishment of the observatory, the geological survey, and the electrical laboratory. A letter written by Prof. Harriss from Chapel Hill, April 10, 1795, shows something of the spirit which Dr. Caldwell was to find in the young university. In it this Princeton man says: "The constitution of this college is on a more liberal plan than that of any other in America, and by the amendments which I think it will receive at the next meeting of the trustees its usefulness will

probably be much promoted. The notion that true learning consists rather in exercising the reasoning faculties and laying up a store of useful knowledge, than in overloading the memory with words of dead languages, is becoming daily more prevalent. It is hard to deny a young gentleman the honor of a college, after he has with much labor and painful attention acquired a competent knowledge of the sciences, of composing and speak-



THE OLD TELESCOPES AS THEY ARE TO-DAY IN THE MITCHELL OBSERVATORY.
Drawn by E. L. Harris.

ing with propriety in his own language, and has conned the first principles of whatever might render him useful or creditable in the world, merely because he could not read a language two thousand years old." This letter might well be dated from Boston a century later, for it was nearly a century before such ideas of the essentials of an education were gaining ground with our foremost educators. The literary societies established in 1795 took mottoes in keeping with the spirit of the day, that of the Dialectic Society being "Love of Virtue and Science," and

the motto of the Philanthropic Society, "Virtue, Liberty, and Science."

The first gift to the university, other than lands and money, came from the ladies of Raleigh and Newbern, who contributed a pair of globes, a compass, and a quadrant. The first student, Hinton James, chose as the subjects of his senior forensics, "The Uses of the Sun," "The Commerce of Britain," and "The Motions of the Earth."

ELISHA MITCHELL.
After portrait by Jocelyn.

The young Professor of Mathematics was made president of the university in 1804. His prosperity culminated in 1824, when the financial condition of the university was so good as to allow the trustees to send him to Europe for the purchase of scientific apparatus and books, appropriating six thousand dollars for the purpose.

Soon after his return from Europe President Caldwell planned an observatory, which he built with his own money. The building was finished in 1827, and in the observatory he placed the instruments which he had brought from Europe. These were a meridian transit telescope, made by Simms, of London; an altitude and azimuth telescope, also made by Simms; a telescope for observations on the earth and sky, made by Dolland, of London; and an astronomical clock with a mercurial pendulum, made by Molineux, of London. To these stationary instruments were added a sextant, made by Wilkinson, of London; a portable reflecting circle, made by Harris, of London; and a Hadley's quadrant.

Before the completion of the observatory building, the clock and meridian transit were set up and used in the library of the university, which was also Prof. Caldwell's lecture room. Here began, in 1825, the first systematic observations upon the heavens made in the United States. Dr. Caldwell was assisted by Profs. Mitchell and Phillips, and their first work was to find the approximate values of the longitude and the latitude of the building in which they worked. Mitchell was a Yale man of the class of

1813, a native of Connecticut, and a descendant of John Eliot, the apostle to the Indians. Phillips was an Englishman, and a son of a clergyman of the Church of England.

Upon its completion in 1827 the instruments were moved into the observatory, where observations were made by Dr. Caldwell and his colleagues. The materials used in the building were very poor; the bricks in the wall soon crumbled, and it became necessary, soon after the death of Dr. Caldwell, in January, 1835, to remove the instruments. The building then went rapidly to decay, and fell a victim to fire in 1838.

Observations were, however, continued by Dr. Elisha Mitchell in the attic of the large wooden building which he used as a chemical and metallurgical laboratory. In each end of the attic were two large windows, and in the roof eight others, four on either side. These observations were continued until the summer of 1857, when Prof. Mitchell lost his life upon the highest peak east of the Mississippi River, the mountain which bears his name. By his observations in 1835, 1838, 1844, and 1856 he had established the fact that the peaks of the Black Mountains in North Carolina are the highest east of the Mississippi.

JAMES PHILLIPS.
After portrait by W. G. Brown.

Prof. Phillips has told us that in order "to study the constellations and to show them to his pupils, Dr. Caldwell built on the top of his own residence a platform surrounded by a railing. Here he would sit night after night, pointing out to the seniors, taken in squads of three or four, the outlines of the constellations and their principal stars, and the highway of the planets and the moon. Dr. Caldwell also built in his garden, where they still stand, two pillars of brick, that their eastern and western faces, carefully ground into the same plane, might mark the true meridian. Near these pillars stood a stone pillar, some five feet high, bearing upon its top a sundial for marking the hours of the day."

Before the coming of Mitchell, Princeton thought and Princeton methods had prevailed in the University of North Carolina to the exclusion of all others. But in 1817, Denison Olmsted, a classmate of Mitchell's at Yale, was elected Professor of Chemistry and Geology. Messrs. Mitchell and Olmsted were recommended to Judge William Gaston, then a member of Congress, by the Rev. Sereno Dwight, chaplain of the United States Senate, as young men who were likely to become prominent scientists; and the trustees, upon this recommendation, and upon that of Hon. George E. Badger, who had been their classmate at Yale, offered them chairs in the university.

DENISON OLMSTED.
After a daguerreotype by Moulthrop.

In 1821 Olmsted laid before the Board of Internal Improvements of North Carolina a proposition to undertake a geological and mineralogical survey of the State. This letter is preserved in the executive office at Raleigh. The board approved, and presented the matter to the Legislature. But the Legislature took no notice of the matter until two years later, when the proposition was renewed. The survey was authorized by act of the General Assembly, ratified December 31, 1823. Prof. Olmsted was appointed to begin the survey under direction of the State Board of Agriculture, prosecuting the work during the vacations of the university. Thus was established the first geological survey by public authority in America. It was sus-

FIRST OBSERVATORY.
Drawn from description furnished by John H. Watson, Esq., Mayor of Chapel Hill, N. C.

tained by an annual appropriation of two hundred and fifty dollars, continued for five years. When Mr. Olmsted resigned in 1825 to accept a professorship at Yale, Dr. Mitchell took up the work of the survey in addition to the duties of his professorship in the university. Olmsted's report was published in two parts, in 1824 and 1825, and filled in all about one hundred and twenty

THE ASTRONOMICAL CLOCK.
This clock still keeps the time for the university.
Drawn by E. L. Harris.

octavo pages. The American Journal of Science observes of this survey that, regarded especially as the gratuitous vacation work of a single individual, and in view of the state of geological science in this country at the time, it "must certainly be looked upon as creditable in the highest degree both to the enterprise and to the scientific ability of its projector, and it has undoubtedly been of great benefit not only to the State which authorized it, but to the country and to science generally, by

the stimulus which it afforded to similar enterprises in other States."

A few years later, in 1829, we find Dr. Caldwell purchasing of W. and S. Jones, mathematical instrument makers, London, the equipment for an electrical laboratory at the University of North Carolina. The first item on the bill, which lies before me as I write, is "a three-feet plate electrical machine with large branch conductor, supported by two glass pillars, double collectors, mounted in strong mahogany, varnished frame, with six brass legs fitted into brass sockets and screw nuts, negative brass conductor on claw-feet stand from the ground, with connecting slid-

PROF. MITCHELL'S LABORATORY AND OBSERVATORY.
After photograph by Collier Cobb.

ing tubes, brass bells and wires, etc., £45." The total amount of this first bill for electrical apparatus was £153 4*s.* 6*d.*

Dr. Caldwell published a Compendious System of Elementary Geometry, in seven books, to which an eighth is added, containing such other propositions as are elementary; subjoined is a Treatise on Plane Trigonometry. He was one of the earliest advocates in the South of popular education by the State.

Dr. Mitchell was the author of a Manual of Chemistry, a second edition of which was passing through the press at the time of his death; a Manual of Geology, illustrated by a geological map of North Carolina; a Manual of Natural History, and a Geography

of the Holy Land. Between 1830 and 1840 he contributed many valuable articles to Silliman's Journal.

Denison Olmsted became more widely known than either of the other pioneers in science. In the course of his work at Chapel Hill he gave the first geological description of the Deep River coal beds, and of the accompanying New Red sandstone, and referred the strata correctly to the same age with the Richmond coal beds and the Connecticut River sandstones. He began researches to determine the practicability of obtaining illuminating gas from cotton seed, but removed to New Haven before he had secured definite results. His Natural Philosophy, which is still a standard work, appeared in 1831, and his Astronomy, another important work, in 1839.

One wonders why such good beginnings should have borne so little fruit; but when we bear in mind that the institution which thus early fostered science had the greater part of its endowment fund swept away by the civil war, that the spirit of the South since that great event has been largely commercial and industrial, and that the income of the old university, from legislative appropriations, tuition fees, and endowment funds, is only forty-five thousand dollars, the wonder ceases.

THE VIVISECTION QUESTION.

By C. F. HODGE, Ph. D.,
ASSISTANT PROFESSOR OF PHYSIOLOGY, CLARK UNIVERSITY.

III.—THE UTILITY OF VIVISECTION.

ASIDE from the highest "use of science," its satisfaction of man's intellectual wants and its influence upon his character, science has many "practical" values connected with its development. And it is to these "uses" of physiological research that we will confine attention, bearing in mind that we are addressing those who believe that, after duty, human health and happiness are the highest values in the world, and that the greatest evils in the world, after moral evil, are human suffering caused by disease and premature death.

How much "use" humanity has for help in these regards may be seen from a glance at vital statistics. "Of 1,000,000 people starting out in life, 497,000 will die, almost all from disease, before reaching the age of forty-one."* We are losing yearly in this country over 302,806 children under five years of age.† There certainly is no "use" in this.

* Albert Buck. A Treatise on Hygiene and Public Health, vol. ii, pp. 328, 329.

† Tenth Census Compendium, p. 1707.

A recent writer* has actually cited mortality statistics to prove the futility of vivisection. The figures do show that in England since 1850 certain organic diseases have been on the increase, despite the slight advance in our knowledge of them. At first blush this table given by Leffingwell strikes one as a serious argument against the utility of research. On closer inspection, however, it only reveals the astute cunning of this author in the selection of his diseases. Almost without exception these maladies lie very deep in the hereditary tendencies of the race, and we could not expect them to be checked and reversed in so short a time. With increase of wealth and advance in civilization the chance that defectives may leave enfeebled progeny is greatly increased, and that there has not been an even greater increase in these diseases is cause for congratulation. But even if the statistics would support the significance Leffingwell attaches to them, what are we to do about it? The only courageous course would seem to be to acknowledge the extreme difficulty of the problems involved and attack them with redoubled energy. Over two thousand years of clinical observation and empiricism have probably about exhausted possibilities in these directions, so that our only hope would seem to lie in experiment; and the less preliminary experimenting on men, the better. If Leffingwell had been able to prove from statistics that there is no curable disease in the world, he would have had a strong argument. As it stands, however, it must be acknowledged to be the strongest possible argument for the side of research.

The chief point of unfairness of the table lies in Leffingwell's selection of diseases. Why confine attention to statistics of organic disease? In acute diseases, where we would naturally look for the first fruits of scientific work, the gain has been considerable.

In support of this, we may quote a few passages from Newsholme's Vital Statistics. On page 273 he says: "If these children" (the 858,878 born annually in England) "be traced through life, the changes in the death-rates occurring 1871–1880, as compared with 1838–1854, would result in an addition of 1,800,047 years of life shared among them; and since this number of births occurs annually, it may be reasonably inferred that there is an annual addition of nearly 2,000,000 years of life to the community, the greater share in which must be ascribed to sanitary measures. . . . In the decennium 1871–1880, the death-rate from fever fell from an annual average of 885 per million to 484, a decline of forty-five per cent" (page 183). For scarlet fever the decline between 1875 and 1885 was forty-nine per cent (page 185).

From tables, page 101, we see that the death-rate per 1,000 in

* Albert Leffingwell. Vivisection, p. 75, Boston, Mass., 1889 (date of introduction).

1838–'40 was, for males, 23·3; in 1887, only 19·8; for females, in 1838–'40, 22·5; in 1887, only 17·8.

From comparing death-rates for the ten years before and after 1872, the year of the passage of the Public Health Act, we find that "no less than 392,749 persons who, under the old *régime*, would have died, were, as a matter of fact, still living at the close of 1881. . . . Add to these saved lives the avoidance of at least four times as many attacks of non-fatal illness, and we have the total profits as yet received from our sanitary expenditure" (p. 127). "We may add that if the death-rates between 1881–1888 are included, the improvement becomes even more striking." Thus:

	Record of years.	Mean annual death-rate per 1,000.
Public Health Act, 1872.	Ten years, 1862–'71	22·6
	Four " 1872–'75	21·8
	Five " 1875–'80	20·79
	" " 1881–'85	19·30
	1886	19·38
	1887	18·79
	1888	17·83*
For Boston,	1892	23·3
" London,	1887	19·6
" Lowell, Mass.,	1892	26·6
" Massachusetts,	1892	20·6†

We are frequently met here by the statement that improved sanitary measures have nothing to do with vivisection. But, in order to gain the passage of costly sanitary measures, sound reasons must be given; these are drawn almost wholly from the pure sciences of physiology and hygiene, and in just those points which bear on public sanitation science owes much to experiment as an essential part. The truth of this we shall see more and more clearly as we proceed.

The most encouraging feature in the comparison of the new with the old tables of vital statistics is the decrease in child mortality. Newsholme, page 101, gives tables of annual death-rates by age-groups from 1838 to 1887. From this we see that whereas in 1838–'40, in every thousand infants born, 72·6 died under five years of age, in 1887 only 57·8 were lost—a gain of over twenty per cent. Abbreviating the table, we have, per thousand births:

Age—	0 to 5 years.	5 to 10 years.	10 to 15 years.
1838–'40, died	72·6	9·7	5·3
1887, died	57·8	4·9	2·9
A gain of	20·5	49·5	45·2

* Arthur Newsholme. The Elements of Vital Statistics. London, 1889.

† A Summary of the Vital Statistics of the New England States for the Year 1892. Boston and London.

These things give us ground for courage and hope, but not for rest—not as long as diphtheria is annually taking from the homes of this country its 49,677 children; not while fevers are yearly "baking to death" 126,332 of our people; and while consumption is causing years of suffering and the loss annually to this country of 102,199 valuable lives.

Were this wholesale slaughter the work of a national enemy or of visible wild beasts, the public would not be slow in its appreciation of any attempt to meet the common foe. But the struggle is none the less real, and the intelligence and often the courage and self-sacrifice required to carry it on are no whit less than in the struggles of a race to subdue a savage continent or a human enemy. With the conquest of all the continental areas assured to man, if war, according to the hopes and theories of some, were a thing of the past, the next great step in the development of the race must be this conquest of the forces of disease. A comparatively small branch of the human race has come to face the issue squarely on experimental lines, and to realize the fact that success can be achieved in no other way. The fate of the Hindus stands as a warning that even an Aryan strain may lapse into the abject imbecility of zoölatry and mysticism. The race that meets this stupendous issue, that succeeds in giving to men the laws by observance of which can be attained, not only freedom from disease, but also the development of the highest type of man, that race alone can carry out to its full perfection the evolution of mankind. In course of its development this race will be able to bestow incalculable benefits upon other races and upon even the animal species which it finds useful to preserve.

IV.—THE ARGUMENT AS TO THE UTILITY OF VIVISECTION IN SPECIAL CASES.

Attempts to prove or disprove the utility of vivisection by special cases have needlessly complicated and embittered the discussion. Matters involved in the warmest medical controversy have been freely introduced, and naturally an abundance of strong language has been at the disposal of either side. It must therefore be distinctly understood as we proceed that this is not the place to settle medical controversies nor to write a complete history of useful medicine. We are to deal not with medical controversy nor with medical history, but with pure argument—argument to prove from special instances the use to humanity of vivisectional methods of investigating the processes of living Nature. This being our purpose, we must leave to experts all discussions of such things as antitoxine, hydrophobia inoculation, etc., and confine our attention to cases about which there is the

least medical controversy and about which people generally agree. We will thus select classical cases, the older the better, and only so many as will serve to render the argument clear and to illustrate best the methods of vivisectional work.

The special cases of Harvey, Charles Bell, Magendie, and Claude Bernard have come to be an established feature in every discussion of this subject, and so many wrong impressions regarding them remain uncorrected that we must consider their work at some length.

A knowledge of the circulation of the blood, no intelligent person can deny, has been of great practical value to men. It affords a foundation for all laws of hygiene and for the practice of surgery and medicine.

The first great step in the line of this discovery was made by Galen. "By ligating in a living animal an artery in two places, and opening the vessel between the ligatures, Galen demonstrated that the vessel contained blood. Thus by an experiment upon a living animal, a vivisection, the first great source of error, the supposition that the arteries contained air, was removed, the true nature of an artery demonstrated, and the modern theory of the circulation made possible." *

Whatever may be the claims of Servetus and Cæsalpinus, there can be no doubt that the one man to unite the observations of his predecessors into an intelligible whole, to found his own observations upon experiment, in short, to discover the circulation of the blood as we now understand it, was William Harvey.†

The claim is often made that Harvey discovered the circulation by "thinking," by "inductive reasoning," and not by vivisectional experiment. As well say that Columbus discovered America by thinking and not by experiment. Harvey not only thought out the circulation, which is a very small matter, but he demonstrated it to be a fact by innumerable experiments upon living animals, which is a very great matter. Here, again, we must emphasize the fact that Harvey did not study, and could

* H. C. Chapman. History of the Discovery of the Circulation of the Blood, p. 12. Philadelphia, 1884.

† Read J. H. Baas. Outlines of the History of Medicine. New York, 1889, pp. 527–530. Also Sprengel, in his Geschichte der Arzneykunde, gives Harvey the frontispiece in vol. iv, and devotes forty pages (50–89) to his work of discovering the circulation of the blood. Also Haeser, Lehrbuch der Geschichte der Medicin, vol. ii, pp. 252–262, devotes eleven pages to "Discovery of the Circulation, Harvey." And when a man comes forward and says, "It is only our insular pride which has claimed for him the merit of the discovery," he brands himself as a person with whom it is impossible to reason (as does Lawson Tait, Uselessness of Vivisection upon Animals, p. 6). Any one desirous of investigating the trustworthiness of Tait in such matters can find him fully discussed, in a way he has not been able to answer, in the book Physiological Cruelty, by "Philanthropos," Appendix E, and also in Heidenhein, Vivisection, Leipsic, 1884, pp. 85 ff.

not possibly have studied, in dead animals "the *motion* of the heart and blood in animals." To found his great thesis on a broad basis of experiment, Harvey vivisected a great many kinds of animals, from his own person to "shrimps, snails, and shell-fish."

Chapter I of Harvey's great work, De Motu Cordis et Sanguinis in Animalibus,* begins, "Cum multis vivorum dissectionibus (uti ad manum dabantur) animum ad observandum primum appuli quo cordis motus usum," etc.

Chapter II is entitled Ex vivorum dissectione, qualis sit cordis motus.

Chapter III is entitled Arteriarum motus qualis ex vivorum dissectione.

Chapter IV is entitled Motus cordis et auricularum qualis ex vivorum dissectione.

The argument that Harvey was led to his discovery by "reasoning upon the valves in the veins," as stated by Boyle, is well answered by his translator, Willis,† who points out at some length that "when we turn to Harvey himself, in his works we nowhere find that he approaches his subject from the quarter now particularly indicated" (i. e., from the purpose of the valves in the veins).

Even Harvey was attacked during his life on the ground that the discovery of the circulation was of "no use" (Willis, p. 258), "because men still continued to die."

For Harvey the blood passed through the flesh (*per partium porositates*), and not until the microscope was available was it possible for Malpighi to discover the capillary circulation in 1661. This he did in the exposed lung of a *living* frog.

In recent years Claude Bernard ‡ greatly advanced our knowledge of the circulation by demonstrating, wholly by vivisectional methods, that the flow of the blood is regulated by a nervous mechanism continuously acting to contract or dilate the vessels according to the requirements of each organ or part of the body. Thus it is seen that every important step in the advance of our knowledge of the circulation of the blood has been made by vivisection and could not possibly have been made in any other way.

Similarly, the testimony of Sir Charles Bell is constantly adduced to prove the futility of vivisection. Bell is the anatomist to whom, with Magendie and Johannes Müller, we owe the first

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* Harvei Opera, 1737, or The Motion of the Heart and Blood in Animals. Sydenham edition, London, 1847.

† Willis. William Harvey, a History of the Discovery of the Circulation of the Blood. London, 1878, pp. 301 ff.

‡ Cl. Bernard. Leçons sur le Diabète. Paris, 1877, p. 43.

great advance in the experimental study of the nervous system. He first demonstrated, though in no thoroughly satisfactory manner, the twofold function of the spinal roots. It is true that Bell did say some things derogatory of physiological experiment about the beginning of this century. But it is also true that his actions speak louder than his words. By reference to his works, we find that Bell made this great discovery in the only way possible—viz., by means of vivisectional experiments. He actually vivisected asses, kittens, rabbits, fowls, monkeys, and dogs, performing the same experiments for which Magendie has been so severely criticised.* Charles Bell was exceedingly sensitive upon the point of causing pain to animals, as is shown by several passages in his works; and it is certainly a strong argument for the necessity of vivisection that a man of his sensitive nature should be compelled to resort to this method in order to demonstrate the truth of his theories. It must be remembered that he had no anæsthetics, and therefore his position can not apply to the present discussion of the subject. Were he operating to-day, with chloroform, ether, morphine, chloral, paraldehyde, cocaine, and other anæsthetics at his disposal, he need have had no twinges of conscience about the pain his experiments occasioned.

Magendie completed Bell's work, placing it upon a firm basis by means of experiments for which he has been accused of most atrocious cruelty. It is sufficient to reply that Magendie, too, worked before anæsthetics were discovered, and when people's ideas about physical pain were very different from our ideas at present. And Magendie was, to say the least, as oblivious to his own suffering as he was to that of the animals he experimented upon. When cholera broke out in France, in 1832, he went as a volunteer into the center of the afflicted district, and afterward served in the great cholera hospital, the Hôtel Dieu, during the epidemic in Paris, and for his heroism received the cross of the Legion of Honor †—"The fiend Magendie."

Take, for example, another great line of physiological work than which few discoveries have been of more practical value to human life. Upon a knowledge of the physiology of respiration we build and ventilate, or ought to, at least, dwelling and school houses, audience rooms, and hospitals.

The first important discovery in this line was made by Sir

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* Charles Bell. Idea of a New Anatomy of the Brain. London, 1811. Transcribed by H. U. D., 1813. Also, Nervous System of the Human Body. London, 1830.

† J. C. Dalton. Magendie as a Physiologist. International Review, February, 1880, p. 120. The story of Magendie's repentance and distrust of vivisection, shortly before his death, has often been adduced against this method of research. After careful search through all the accounts of Magendie's life (thirteen in number), Dalton is able to say that there is no intimation of any ground for this idea.

Robert Boyle (1670), who found, by the use of his air pump, that if he deprived animals of air they died. He vivisected in this way kittens, birds, frogs, fish, snakes, and insects.* Boyle also discovered that by keeping animals in a closed reservoir the air became unfit to sustain life.

Priestley, a century later (1772), continued Boyle's experiments by keeping mice in air-tight receivers until the air was vitiated and would no longer support life. He then tried to restore the air to its former condition: he rarefied and condensed it, heated it, exposed it to water and earth, and treated it in many other ways, each time testing it with living mice to ascertain whether it would again support life. All this was to no effect. In every case the mice died. Finally, he found that after plants grew for a while in the vitiated air, mice could again live in it. Thus was discovered the important relation between animal and vegetable respiration, and we now plant trees and lay out parks, and call them the "lungs of our cities." Two points must be emphasized here: first, that Priestley could not have done this with dead mice; and, second, that no one except Lawson Tait and Miss Cobbe would have the hardihood to claim that he ought to have used live men instead of live mice, on grounds of moral rights, and from the fact that the physiology of man is "so different" from the physiology of the mouse.

Turning to still another important line of scientific work, diseases of microbic origin are said to cause four fifths of the sickness in the world. As an example of researches in this field, we may cite the classical work of Edward Jenner.†

Jenner began to study in earnest the disease cowpox, and its relation to smallpox, in 1775. For twenty-one years he patiently investigated the subject, and found that no one who had once suffered an attack of cowpox was taken with smallpox, although frequently exposed. "Legends of the dairymaids" had told for generations that an attack of cowpox conferred exemption from smallpox forever after. Jenner might have told the same story; but, if he had not proved the truth of his assertion by experiment, we might still have nothing but "legends of dairymaids" and no vaccination.

In May of 1796 Jenner began his experiments. He says (page 29): "The more accurately to observe the progress of the infection, I selected a healthy boy, about eight years of age, for the purpose of inoculation for the cowpox." This inoculation was followed by an attack of the disease. But Jenner does not

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* Boyle. Philosophical Transactions, vol. v, pp. 2011–2055.

† Edward Jenner. An Inquiry into the Causes and Effects of the Variolæ Vaccinæ, December 20, 1799. London, 1801.

stop here. Again, he says: "In order to ascertain whether the boy was secure from the contagion of the smallpox, he was inoculated the 1st of July following with variolous matter immediately taken from a pustule. Several punctures were made in both arms, and the matter was carefully inserted, but no disease followed."

Some might have called the discovery complete at this point, but Jenner realized that one case is not every case, and that he must repeat the experiment, which he did scores of times, even going so far as to endanger human life in order to establish the truth of his discovery. For he goes on to say (page 41): "To convince myself that the variolous matter made use of was in a perfect state, I [at the same time that he inoculated a patient previously inoculated with cowpox] inoculated a patient with some of it who had never gone through the cowpox, and it produced the smallpox in the usual regular manner."

Previous to the introduction of vaccination in London the average annual death-rate per million from smallpox was (Newsholme, table, page 192):

1728–'57	4,260	
1771–'80	5,020	
1801–'10	2,040	beginning of Jenner's work.
1872–'82	262	
1885	1,419	
1886	24	
1887	9	

Germany now has the most efficient laws of probably any country for making not only vaccination but repetition at stated intervals obligatory. As a result smallpox is rapidly disappearing. In 1888 the deaths from smallpox in the entire empire amounted to one hundred and ten, less than 2·5 per million, and the majority of these occurred on or near the boundaries of other countries. We can easily appreciate the usefulness of this. Still, during this work Jenner was persecuted and abused.

Jenner's experiments belong to the class of investigations which since 1850 Thiersch has made for cholera, Lister for inflammation of wounds, Pasteur for rabies, Koch and Pasteur for splenic fever, M. Freire for yellow fever, Koch later for cholera, and has now begun to make for consumption.

Thiersch's experiments on cholera, which caused the death of fourteen mice and proved that cholera is communicated by swallowing particles of cholera discharge, have been an important factor in the sanitary legislation of every civilized country.

Two of the London water companies experimented with cholera-polluted water upon 500,000 people, causing the death of 3,476 human beings in 1853–'54. This is the popular accidental

experiment which antivivisection writers tell us to wait for, and which they say is sent by Providence to teach men physiology. Thiersch made the same experiment upon fifty-six mice, the conditions being accurately determined and scientifically controlled, and with the death of fourteen mice gave the world more exact information about the contagion of cholera than all the cholera epidemics recorded in history. This is the scientific experiment which we are told should not be made.*

The antiseptic method, which we owe in so great a measure to the vivisectional experiments of Joseph Lister, is past all reasonable controversy and we may refer to it here. It has come to be used in hospitals generally, and has reduced mortality from surgical operations to one tenth of what it was before. Any one who has seen even a few cases of antiseptic surgery will readily agree with Dr. Keen when he says: "Sir Joseph Lister has done more to save human life and diminish human suffering than any other man of the last fifty years."† Still, Lister was obliged to leave England to continue experiment in his merciful work after the passage of the restrictive law in 1876.

In the Tübingen Hospital died from amputation before introduction of Lister's method and after:

	Per cent.	Per cent.
Of lower limb	43·5	3·2
Of upper limb	30·6	2·9‡

We might extend much further the list of useful discoveries which have depended for some essential part of their development upon vivisectional experiment; but such is not our present purpose. The reader can find these amply discussed elsewhere. We would, however, at this point call special attention to the way in which a discovery of this kind is received. Jenner's smallpox inoculation was obliged to run the same gantlet of popular and professional favor and disfavor as Lister's discovery, as Koch's and Pasteur's are running now. Such discoveries are in even greater danger from ignorant and enthusiastic supporters than from learned opponents. The problems involved are very complicated. Exceptions of every kind occur—e. g., a person may have smallpox twice, and so, although vaccination protects in most cases, it does not in all; and, further, as Jenner himself says, "inoculation sometimes under the best management proves fatal."§

In the case of one of these complications in London, Jenner

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* John Simon. Experiments on Life. London, 1881.

† W. W. Keen. Our Debts to Vivisection. Reprint from Popular Science Monthly, May, 1885, p. 15.

‡ Heidenhain. Die Vivisection, p. 34.

§ Jenner, *loc. cit.*, p. 57.

has himself left a record in strong English of the way he felt. Writing to Moore in 1811 he says: "The town is a fool, an idiot, and will continue in this red-hot, hissing-hot state about this affair until something else starts up to draw aside its attention. I am determined to lock up my brains and think no more *pro bono publico*, and I advise you, my friend, to do the same, for we are sure to get nothing but abuse for it." *

We are, however, discussing the utility of a method, and while we will not introduce Koch's treatment as an argument for the utility of vivisection until it has been perfected and the medical profession has reached a decision as to its value, we can hardly find a better example of the vivisectional method. Koch's method is that of Jenner perfected by using animals instead of men. His discovery in 1882 of the tubercle bacillus has already become of inestimable value in directing sanitary measures and in recognizing the earlier stages of consumption while cure is possible. This, we are told by an antivivisection writer, "was discovered by the microscope, not by vivisection." † How did Koch make this discovery?

It is true the microscope assisted as spectacles help to read. But Koch, in the examination of tuberculous matter, discovered a number of germs with the microscope. Which one of these caused consumption no number of microscopes could tell him. This had to be settled by most careful experiments. There are several steps in the process. The first is to identify all the different kinds of microbes found constantly in tuberculous bodies. For convenience we will call these microbes *a*, *b*, *c*, *d*. These are mingled together. The second step is to cultivate these germs in one test tube after another until perfectly "pure cultures" are obtained—i. e., nothing but *a's* in one, nothing but *b's* in another, and so on. Up to this stage he has not the least idea which of these is the germ of consumption. The only way he can determine this point is by experimenting upon living animals. He must then inoculate a number of healthy animals, one with germ *a*, another with germ *b*, another with germ *c*, another with germ *d*. The four animals are now watched carefully. The animal inoculated with germ *a*, we will say, sickens and dies with unmistakable symptoms of tuberculosis. Those inoculated with germs *b*, *c*, and *d* are not affected. He repeats the experiment several times, and if each time with the same result is justified in concluding that germ *a* is the cause of tuberculosis, while the other germs are harmless.

This is but the first stage in the investigation. After the dis-

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* Crookshank, *op. cit.*, fol. i, p. 139.

† Ernest Bell, M. A. Weighed and Found Wanting, Victoria St. Society publication.

covery of the cause comes the question, How can this cause be controlled? How can its action be prevented? Here, as Koch says, men have begun at the wrong end of the problem. Since the beginning of medicine the doctors have been experimenting upon men to find a cure for consumption. The problem here is too complicated, and in consequence little has been learned. Experiment must begin, he says, with the bacillus itself. We must grow it first in pure cultures in test tubes, in all manner of different culture media and under all conditions of temperature and light, in order to ascertain under what conditions it grows best and under what conditions it can not grow. We must next subject it in the test tube to the influence of different chemical substances, and when some compound is discovered to kill or hinder the growth of the bacillus in the culture, then the substance must be tried upon tuberculous animals to ascertain whether in their bodies as in the test tube it will act to kill the bacilli without injuring the animal. When a substance fatal to the bacillus and harmless to the animal is found, with all due allowance for differences between the animal and man, it may be tested on man.

This, in brief, is but one important line of research, and clearly it should be carried out thoroughly for every infectious disease. A single link in the chain of procedure requires absolutely to be welded by experiments upon living animals. With millions on millions of human beings and animals suffering and dying yearly for lack of this knowledge, no truly humane person can for a moment deny to an investigator the right to complete his work by introducing this link.

In view of the stupendous values involved it is clear that any amount necessary of animal or human sacrifice and suffering is wholly justified. Whether unnecessary suffering is inflicted is a question which only the highest experts can adequately decide. Prof. Bowditch* has so thoroughly discussed the subject of pain caused by vivisection that we would pass it by without mention, were it not for the fact that the public mind has been of late so much abused by misstatement and exaggeration on this head. Prof. Yeo's estimate, the most reliable we have, is that in every one hundred experiments seventy-five are "absolutely painless," twenty are as "painful as vaccination," four, as "painful as the healing of a wound," one, as "painful as a surgical operation." The pain of vaccination is altogether trifling, and that of the healing of a wound after antiseptic treatment is also practically nil. This leaves but one per cent of all experiments as painful to any serious degree. During over ten years' active experience in

* H. P. Bowditch. The Advancement of Medicine by Research. Science, July 24, 1896.

three laboratories in this country and a number of the leading laboratories abroad, I have never had occasion to perform or witness an experiment of this painful class. Discovery of new anæsthetics and more recent methods of operation have doubtless reduced the pain of experimentation even below Yeo's estimate. In all laboratories in this country, and equally abroad, I have always found anæsthetics adequately and uniformly employed.

In the recent discussions before the House Judiciary Committee of Massachusetts upon the bill relating to inspection of vivisectional experiments in the medical schools and universities of the State, none of the petitioners for the bill were able to cite a single case, or the reasonable suspicion of a case, of abuse of vivisection, as having occurred within the State of Massachusetts. In order to obtain as reliable data as possible upon this point, I sent blank tables, arranged according to the table below, to all the laboratories in Massachusetts where vivisectional experiments were likely to be made. Returns were kindly sent in from all the laboratories, and may safely be taken to represent the experimental work in the State during the year 1894–'95.

Animal.	Number used.	Painless.	Painful as			
			Vaccination.	Healing of wound.	Effect of poison.	Disease.
Frogs	866	845	4	..	17	...
Pigeons	23	19	..	4	..	...
Rats	25	25	..	..	..	...
Rabbits	146	61	50	..	5	30
Guinea-pigs	465	..	150	..	..	315
Cats	22	18	..	..	4	...
Dogs	95	91	..	3	2	...
Mice	30	10	..	..	..	20
Squirrels	3	3	..	..	..	...
Totals	1,675	1,072 (64%)	204 (12·2%)	6 (0·4%)	28 (1·6%)	365 (21·8%)

Contrast with this the 34,419 human beings who die of disease annually in Massachusetts.

A general principle underlying vivisectional work is also revealed in the table, viz., that the lowest animal adequate for the purposes of the research be employed in preference to one more highly organized. This entirely negatives an assumption often advanced that animal vivisection tends toward human vivisection. The whole tendency of modern physiology has been exactly the reverse. Animals have come to be used in order to save human beings from abuse.* In the very beginning of medicine

* The recent action of Dr. J. S. Pyle (A Plea for the Appropriation of Criminals condemned to Capital Punishment to the Experimental Physiologist, Canton, Ohio, 1893), so

every attempt to cure disease or alleviate suffering must have been, in the nature of the case, an act of human vivisection. A large proportion of modern medicine at present is equally in essence nothing more nor less than human vivisection, and it is only gradually, as elements of experiment and uncertainty are eliminated from remedial measures by more exact knowledge, that the practice of medicine becomes anything more than human vivisection.*

A further argument against the utility of animal experimentation is based on differences between animals and men, which make it unsafe to apply results directly from the animal to man. A logical error is here involved; for, while there are physiological differences between different animals, to one point of difference there are many points of close similarity. A difference in physiological function is technically known as an idiosyncrasy. These differences exist between individual men as well as between different species of animals. A man who has had smallpox or measles acquires an idiosyncrasy which protects him from having them again. In some cases this difference exists from birth; in others it is impossible to acquire it. Man himself begins life as a microscopical speck of living matter, and in his physical development passes through and beyond the lower stages of organic life. Hence the fundamental physiological processes and functions he has in common with the great body of living things beneath him. On this wider view physiological idiosyncrasy becomes the strongest possible incentive to experiment. How is it that certain species have become wholly immune from certain diseases? With the secret of this immunity discovered, it may be easy to induce a similar immunity in another species or in man.

The conclusion which follows from the foregoing chapters bears directly upon a topic of considerable present importance, viz., that of legislative interference with scientific work.† With due appreciation of scientific achievements in the past, we must keep ever before us the fact that the hardest labors and richest harvests in science are still in the future. And every consideration of religion, morality, altruism, humanity, and utility urge to

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far as I have been able to ascertain, is an individual matter, and can not be taken to represent in the slightest degree the tendency of experimental medicine or the attitude of experimental physiologists in this country.

* The Zend-Avesta permitted a doctor to practice his art upon three heretics. If these all died or were made worse by his treatment, he was forbidden, on penalty of death, to follow his profession further. If they recovered, he might begin practice upon the faithful.—Sprengel. Geschichte der Arzneykunde, vol. i, p. 126. (Refers to Zend-Avesta, Part III, p. 336.)

† For fuller discussion of this topic see Bowditch, *loc. cit.*, pp. 8–16, and appendix.

the prosecution of physiological education and research with unabated energy. Hence no legislative action should be taken which could possibly offer hindrance or annoyance to either teachers or investigators.

In accordance with the pernicious principle that a law can do no harm except to offenders, the English Parliament, in 1876, passed an act severely restricting vivisectional work. This action of England was promptly reversed by every other European nation where the subject was agitated, and by every State Legislature in this country to which the matter has been referred. Within the past year this reversal has been reaffirmed in Switzerland and in Massachusetts. The restrictive act in England served not in the least to abate the agitation and protect physiologists in their work, as was intended; but, as an eminent English physiologist puts it, has "only tended to encourage the opponents of science in their vexatious interference." English antivivisectionists under this encouragement have shifted position from restriction to total abolition, and have increased the agitation. We have in this country at least three societies organized on the platform of total abolition of physiological experiments. The legislative measures advanced thus far by these organizations have been mild in the main; but while they emphasize before the public the fact that their laws do not aim to "prohibit" experiments, they are also unguarded enough to speak of them as "the entering wedge for more radical measures in the future."* Clearly, for medical and scientific faculties, for medical societies, and for all who have at heart the advancement of humanity and science, the strategic point at which to meet the enemy is the point of "the entering wedge."

After conscientiously reading their literature for the past five years I feel warranted in saying that science has little to fear from the efforts of the antivivisection societies. Their methods of agitation would sink even a worthy cause. The real danger lies with scientific men themselves who entertain ideas of conciliation and compromise which will admit the point of the "entering wedge." Prof. Michael Foster has had the benefit of twenty years' experience in conducting a laboratory under restrictive legislation, and his advice should certainly carry great weight. He writes as follows: "My earnest advice" (to us in America) "is to straighten your backs, and, knowing that no legislation is necessary on grounds of humanity, and that all legislation is bad for science, strain every effort to defeat the agitation."†

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* Antivivisection, June, 1896, pp. 9 and 13. Aurora, Ill.

† Private letter from Prof. Foster to the writer, under date of February 1, 1896.

ACETYLENE, THE NEW ILLUMINANT.

By V. J. YOUMANS.

THE advent of the electric light, the Siemens-Lungren regenerative burner, and the Welsbach incandescent mantle, all within a comparatively short period, threw the lighting industry into a very unsettled condition. There had begun, however, to appear some order out of the chaos. As the special advantages of the different systems were recognized, the purposes to which each was best adapted were noted. The development of the industries was going on very satisfactorily, when a new competitor appeared in the shape of acetylene. It is now stated that Mr. Edison and Nikola Tesla are independently working out still another system, based on the vacuum-tube phenomena; a subject in which Mr. D. McFarlan Moore claims also to have made a great step in advance by the invention of his vacuum vibrator. Vacuum-tube lighting, however, is still in the laboratory, and, while surprising tales are told of its great beauty and high efficiency, it is too soon to even prophesy intelligently regarding it. Acetylene has, however, during the last few years been much discussed, and considerable data are available regarding it; so that an inquiry into its history and value as a practical illuminant is of interest.

Acetylene (C_2H_2) was first described by Edmund Davy, who obtained it accidentally by the action of water on a mass of carbonized tartar and charcoal powder, with which he had attempted to prepare potassium. He called the new gas *klumene*. Some years later it was rediscovered by Berthelot, who obtained it by passing ethylene through a red-hot tube; he noted its occurrence in coal gas, and later succeeded in making it by passing a powerful electric current between two carbon poles in an atmosphere of hydrogen.

The resulting mixture of acetylene and hydrogen was passed into an ammoniacal solution of cuprous chloride, and the insoluble copper compound thus obtained, which is extremely explosive and has recently caused several serious accidents, was then treated with hydrochloric acid, which liberated acetylene.

Acetylene is a colorless gas, having a rather disagreeable odor, somewhat resembling garlic and phosphorus. The peculiar odor noticed when the burners of a gas stove strike back is due to the formation of acetylene. Its specific gravity when compared with air is 0·91 (ordinary coal gas has a specific gravity of about 0·607). At 0°, and under a pressure of 21·5 atmospheres (322·5 pounds per square inch), it becomes a mobile, highly refractive liquid. Water at 18° dissolves its own volume of the gas. When ignited at an ordinary burner it gives a smoky, dull flame, and with oxygen

forms an explosive mixture, as it does also when mixed in certain proportions with air; but when burned through a very small tip and under slight pressure, or when mixed with coal gas or air in proper proportions, an exceedingly brilliant and highly luminous flame is produced. Acetylene is poisonous, combining with the hæmoglobin of the blood, to the exclusion of oxygen, to form a compound similar to that yielded by carbon monoxide. Moissan, however, reports that when prepared from pure calcium carbide, and after being purified by liquefaction, it has an ethereal odor, and can be breathed in small quantities without evil effects. Regarding its explosiveness Mr. J. M. Crafts says: "Experiments, using a two-inch gas pipe as a cannon, show that from five to six per cent of acetylene mixed with air forms an explosive mixture. . . . About ten per cent of water gas is necessary before an explosive mixture with air is formed." Explosive mixtures in the air of a room would be produced by much smaller percentages than these. Lechattelier gives 2·8 per cent acetylene mixed with air as an explosive compound. So far as its poisonous qualities are concerned, acetylene seems to have a little the advantage of water gas; the poisonous principle of the latter is carbon monoxide, whose combination with the blood is somewhat more energetic than that of acetylene, and which has no odor to serve as a warning in case of a leak, as has acetylene. Acetylene is, however, more prone to form explosive mixtures. This is due to the fact that in the combination of carbon and hydrogen to form acetylene 61·100 units of heat are absorbed. Thus the heating power of a cubic foot of acetylene is sufficient to raise 407 kilogrammes (a kilogramme = 2·2 pounds) of water 1° C. The combustion of the same amounts of uncombined carbon and hydrogen as are present in a cubic foot of acetylene will raise only 336·5 kilogrammes of water to 1° C., leaving a difference in favor of acetylene of 70·5 heat units—the unit being the amount of heat required to raise the temperature of one kilogramme of water 1° C.

Acetylene is one of the important bodies, much used by the chemist in the synthesis of organic compounds. It is also reported to be of value in polariscope work, permitting the reading of solutions so highly colored as to be opaque to the ordinary sources of light. Some interesting experiments with the gas in abnormal physical states were recently performed by J. J. Suckert, during a lecture before the Franklin Institute. A tube of liquefied acetylene was cooled to −28° F., and then the pressure removed. Rapid evaporation took place, and a portion of the liquid gas was solidified into a snowlike mass whose temperature was found to be −118° F. A part of this snow placed on some mercury in a saucer soon froze the latter, and another portion, on being dropped into water, upon which it floated, gave off acetylene

gas, which was readily ignited and burned with its characteristic sooty flame.

Regarding the illuminating power of acetylene, a proper burner using five cubic feet per hour will give from two hundred to two hundred and forty candle power. Five cubic feet of ordinary gas give from fifteen to thirty candle power; that is, a cubic foot of acetylene will give about eight times as much light as the same amount of coal or water gas. Indeed, it is claimed by Prof. Lewes and others that the formation of acetylene in the ordinary gas flame accounts for the latter's luminosity, and it has been proposed to enrich water gas by the addition of a small amount of acetylene; but so much of the latter was found necessary to produce any appreciable result as to render the process impracticable. Acetylene requires a much larger amount of air for complete combustion than does ordinary gas. This is a distinct disadvantage, as the large amount of air cools the flame, and thus diminishes its luminosity. The temperature of the acetylene flame is about 1000° C., that of an ordinary flat coal-gas flame being 1360° C.

The present rise into prominence of acetylene, which up to 1888 was simply a laboratory product, is due to the discovery of the formation of calcium carbide in the electric furnace. There is some controversy as to who first made this discovery, but the honors seem to belong to Mr. T. L. Wilson, of the Wilson Aluminum Works. In 1888 Mr. Wilson began a series of experiments with the electric furnace for reducing refractory ores; during one of these a curious, dark-brown, dense mass was formed, whose immersion in water produced a violent evolution of gas, which upon investigation proved to be acetylene. A French chemist, Moissan, independently discovered the process, and reported it at the meeting of the French Academy, in December, 1892. But as Mr. Wilson sent samples of the carbide to Lord Kelvin in the summer of 1892, for examination, he seems to have preceded Moissan, at any rate in announcing his discovery. All the alkaline earths form carbides in a similar way, which, when treated with water, give off acetylene. It may be interesting to note, in passing, that by means of the electric furnace, a carbide of silicon has recently been obtained, which under the name of carborundum is coming to be used extensively as a polishing and grinding material. It is extremely hard (scratching rubies) and is said to wear well. Another interesting product is the carbide of titanium, the hardness of which is sufficient to scratch the diamond. This discovery of the ready formation of carbides under the great heat of the electric furnace is of special interest to the geologist, as bearing on the theory that these carbides are present in large quantities in the interior regions, to which water must occasionally penetrate; the resulting generation of gases

and production of high pressures and heat accounting for the various volcanic disturbances and the large natural deposits of petroleum and other carbonaceous material, which occur so abundantly in some districts.

Pure calcium carbide has a specific gravity of 2·262; in a dry atmosphere it is odorless, but upon exposure to moisture evolves the peculiar odor of acetylene. When exposed in lumps to the action of ordinary air it becomes coated with a layer of hydrate of lime, which protects the interior of the mass from further oxidation. It is not inflammable, and can be exposed to the heat of the ordinary blast furnace without decomposition. It is, in fact, a very stable compound, its ready decomposition under the action of water being quite at variance with its other chemical properties. It was first prepared by Woehler, in 1862, by fusing an alloy of zinc and calcium with carbon. He called it acetylene carbide. It forms a dark grayish or red dense mass, which upon fracture shows a crystalline metallic surface. The whole process of manufacturing acetylene, from the preparation of the lime and coke onward, is very simple, and the only reason why it is new as a commercial product is the difficulty of causing a combination between the calcium of the lime and the carbon of the coke. Nothing short of the temperature of the electric furnace (3500° to 4000° C.) will bring this about, and the comparative modernness of this apparatus accounts for the lateness of the calcium carbide. The chemistry of the process is as follows: Quicklime (CaO) and coke, or any other substance whose main content is carbon (C), are mixed and fused together in the electric furnace. The calcium (Ca) of the lime combines with part of the carbon (C) of the coke to form calcium carbide (CaC_2); the oxygen (O) of the quicklime combining with another portion of the carbon to form carbonic oxide:

$$\underset{\text{Quicklime.}}{CaO} + \underset{\text{Coke.}}{3C} = \underset{\text{Calcium carbide.}}{CaC_2} + \underset{\text{Carbonic oxide.}}{CO}$$

Carbonic oxide is a gas and is driven off, leaving calcium carbide and the various impurities in the furnace. The further reaction to form acetylene occurs when calcium carbide is subjected to the action of water:

$$\underset{\text{Calcium carbide.}}{CaC_2} + \underset{\text{Water.}}{2(H_2O)} = \underset{\text{Slaked lime.}}{Ca(OH)_2} + \underset{\text{Acetylene.}}{C_2H_2}$$

The following description of the commercial manufacture of calcium carbide as conducted at Spray is based on a paper by G. de Chalmot, who for some time had personal supervision of the works of the Wilson Aluminum Company at Spray, N. C., and

an address by W. R. Addicks, of Boston, Mass., delivered before the New England Association of Gas Engineers at their twenty-sixth annual meeting:

The electric furnace is of ordinary brick, two and a half by three feet (inside measurements) at the bottom. The front side consists of four iron doors. The electric current enters at the bottom and top; the lower electrode is an iron plate covered with eight inches of carbon (pieces of carbon pencils or a mixture of coke and coal tar). Sixteen copper cables 0·75 inch in diameter convey the electricity from the dynamos to the bottom electrode; sixteen other cables are connected with the top electrode, which is composed of six carbon pencils each four inches square and thirty-six inches long; these are bound together by a sheet of iron, so as to really form only one pencil. The upper electrode is so arranged that it can be raised or lowered by means of a screw. Dynamos giving a current of from fifty to one hundred volts and seventeen hundred to two thousand ampères are used, actuated by a water wheel of three hundred horse-power capacity. To start the furnace a little carefully ground and mixed lime and coke (this being done by special grinding and mixing machinery, which forms an essential part of the plant) is thrown on the bottom of the furnace, the current turned on, and the upper electrode lowered until an arc is formed between it and the mixture. The carbide soon begins to form, and new material is shoveled in as the ingot is built up. The end of the pencil is kept covered with about a foot of the mixture, and is gradually raised by the attendant until the capacity of the furnace is reached; then the current is turned off and the furnace left to cool. This constitutes the whole process, and is extremely simple and inexpensive, requiring no skilled labor and little machinery. Much time has been lost at Spray in waiting for the furnace to cool, which requires from four to eight hours. In the new plant of the Philadelphia company at Niagara the lower electrode and the bottom of the furnace consist of a car, which, as soon as the run is finished, can be drawn out and a fresh car substituted, thus obviating the loss of time and heat in waiting for the furnace to cool. Many other improvements, including an arrangement by which the mixed lime and coke are automatically fed into the furnace, are expected to materially reduce the cost of manufacture at the Niagara works.

The proportions of lime and coke are roughly calculated by means of the atomic weights involved in the reaction, but in practice it is found that, owing to impurities and loss in the process, these amounts have to be exceeded somewhat. After the mass in the furnace has cooled sufficiently, it is dumped on a grate which holds the carbide and permits the unreduced material, amount-

ing to from fifty to seventy-five per cent of the original mass, to fall through into a bin, from which it is collected to be used again. The lime requires to be fairly pure, over five per cent of impurities interfering seriously with the production of carbide. Magnesia is very undesirable, and it is stated that if over three per cent is present a good quality of carbide can not be made. This matter of impurities and the care of the carbon pencils, which when properly looked after wear away only about 0·09 of an inch per hour, but which may make a great deal of trouble if carelessly tended, are the points requiring special attention. Unslaked lime is said to give the best results. The alternating current is used at Spray, but a direct current can be employed. Besides coke, soft coal, anthracite, charcoal, pitch, tar, resin, and asphalt have been tried in combination with lime. Indeed, the first mixture used by Mr. Wilson was lime and tar, which had been boiled together in a caldron and then thoroughly dried. With the exception of charcoal, however, none of these substances were found of any value as compared with coke, although they all produced some carbide. As regards the amount and quality of the light obtained from acetylene properly burned, there seems no question as to its great superiority over either ordinary coal or water gas. It stands about even with water gas in poisonous qualities, but is more liable to explosion. Greater care would be required in handling it, especially if the proposition, which was at first well received, to use it in a liquefied state from cylinders under great pressure, should prove practicable.

Its success as an illuminant, however, depends almost entirely on the cost of manufacture, and regarding this point it is somewhat difficult at present to get reliable data, chiefly, perhaps, because of the experimental stage in which much of the apparatus still is.

The Progressive Age, a New York publication devoted to the interests of electricity, gas, and water, recently formed a commission which it sent down to Spray for the purpose of determining the actual cost of manufacturing calcium carbide. The commissioners were Prof. Houston and Drs. Kennelly and Kinnicutt, and their conclusions, after careful examination of the works and a testing of two full runs, were published in the Progressive Age for April 15th, and are as follows:

"Our estimate, therefore, of the cost of producing calcium carbide at Spray, by working the furnaces three hundred and sixty-five days a year and twenty-four hours a day, yielding on the average one ton of two thousand pounds gross carbide a day, is $32.76 per ton. Of this amount $14.39 is for material. The freight charges on lime and coke are heavy at Spray, and add materially to the cost."

They found an average net yield of acetylene of 4·926 cubic feet of moist gas per pound of net carbide, or 4·696 cubic feet per pound of gross carbide. A gross ton of carbide, then, will yield about 9,400 cubic feet of acetylene at a cost very slightly above $32.76, as the final formation of acetylene is practically without expense. Nine thousand four hundred cubic feet of coal or water gas costs the consumer somewhere between fourteen and sixteen dollars, roughly about one half as much as the same amount of acetylene. But as acetylene gives over eight times as much light per cubic foot, a large margin seems to be left for decreased gas bills to the consumer and increased profit for the producer. On the whole, then, it may be said that acetylene promises to be an important rival of the present methods of illumination, and deserves the careful examination of both the consumer and manufacturer of light-givers.

It has been proposed to use calcium carbide as a concentrated fuel on war vessels and in places where space is of more importance than cost. Dr. Frank has made the following calculation of the gain in space over coal: To provide power for a one-thousand-horse marine engine for twenty-five days would require four hundred and thirteen tons of coal, occupying a space of about fifteen hundred cubic feet. In this space could be stored enough of the carbide to propel the ship at the same rate for seventy-five days. In other words, as a fuel one ton of carbide is equal to three tons of coal. There are works engaged in the manufacture of calcium carbide at Spray, N. C., at Niagara Falls and at Lockport, N. Y.; in Europe, at Betterfeld, Prussia, at Neuhausen, Switzerland, at Baden, in Germany, and at Troyes and Vallorbes, in France.

THE native Micronesian population of the Marshall Islands is represented by Dr. Steinbach to be rather increasing than decreasing—a census on one of the islands showing an increase of about fifteen per thousand a year. The density is about sixty-eight to the mile. The people are divided into four sharply defined classes: the common people, or Kayur; the next higher class, the Leataketak, comparable with the village magistrates in Germany, who see that the orders of the chief are carried out; the ordinary chiefs, Burak; and the Iroj, or head chiefs. Neither of the two lower classes own land, but they are allowed to grow as much produce or catch as much fish as is necessary for their sustenance; and they have to perform certain services for the chiefs. The ordinary chiefs often possess larger holdings than the Iroj, or head chiefs. All the members of the four classes acquire their rank through the mother only. The son of a woman of the Iroj class is always an Iroj, even though the father be a common Kayur. The chiefs have still considerable dignity and power, including that of life and death.

THE SIGNIFICANCE OF LEAVES.

By F. SCHUYLER MATHEWS.

WHILE we admire and enjoy the greenness and the general effect of foliage, and regard the forms of single trees if they are particularly graceful or otherwise peculiar in shape, we seldom give special attention to individual leaves, but are rather inclined to neglect them as common and trivial. Yet, as Mr. F. Schuyler Mathews * well says, while they may be common, "they are far from commonplace. If we doubt this, let us try to draw or paint a single leaf. Only a great artist can depict *all* of some *one* of its manifold truths; one may draw ever so carefully and

FIG. 1.—WHITE PINE, LEAF AT A.

well, yet he can not tell with the pencil or the brush all the truth and beauty of one leaf. Its color is too waxen and pure to be imitated by earthy pigments; its outline is too subtile, its teeth are too finely and vigorously formed, and its veins are too infinitely complex for one to copy with absolute, lifelike accuracy. No, it is not possible to portray all the beauty of a leaf with the pencil. Yet this work of Nature's wonderful art is common: the

* Familiar Trees and their Leaves. By F. Schuyler Mathews. With an Introduction by Prof. L. H. Bailey. Published by D. Appleton & Co.

world is filled with untold billions of leaves, no two of which are exactly alike. "It is undoubtedly the fact that we do not fully appreciate either the beauty or the usefulness of trees; but after

FIG. 2.—CATALPA LEAF.

we have become really familiar with them, and have learned readily to distinguish the different species, we find ourselves in a new world of absorbing interest, in which beauty and use have expanded to proportions far beyond our previous conceptions."

Many pleasant and profitable lessons can be learned from Mr. Mathews's two hundred and odd sketches of leaves taken from Nature, with their accompanying brief descriptions. The single lesson to which we would here call attention is the variety in the forms of leaves. The purpose and condition of the life of the tree are revealed in no small measure by its leaves.

The needle of the pine enables the tree to withstand a hurricane on a mountain top, yet its slender figure is perfectly adapted to the task of gathering light and air for the tree's life.

Not less plainly does the diversity of character in a leaf reveal the diversity of tree life itself. No two leaves are exactly alike;

no two trees are exactly alike. There are specific as well as generic differences which are strongly marked. One tree leads a rugged, wild, and struggling life; another an easy, luxurious life. The rough and fuzzy leaf of the slippery elm, the silky leaf of the beech, the shiny leaf of the gray birch, these are all widely different; but there are also distinct differences between the leaves of the several kinds of birches, elms, and maples.

Still, there are puzzling similarities, and one is often compelled to study minute details in order to make sure of a particular species. The catalpa leaf is mentioned as that having the simplest form. It is without divisions, and has an entire and unbroken edge. The magnolia leaf, which is oval, might as well have been

FIG. 3.—WHITE OAK.

taken as the type; and there are others equally simple. The most complex form of leaf is exemplified in that of the horse-chestnut.

A very interesting exercise may he had in tracing the differences in the shapes of the leaves of trees of the same family,

as of the oaks, where we have the rounded lobed leaf of the white oak, the pointed lobed red-oak leaf, and the obovate, evergreen leaf of the red oak, with numerous transitional and derivative shapes. In the maples, too, the typical three-lobed, deeply indented leaf branches out into a great diversity of forms, all easily referable, however, to the primitive one, the peculiarities of which are dependent upon the depth, the number, and the minuteness of the notchings. Another series of sports is shown in

FIG. 4.—RED OAK.

FIG. 5.—LIVE OAK.

the birch leaves, where the pointed, serrated leaves of the black and yellow birch are quite different in shape and general appearance from the pointed, much-notched, glossy, isosceles-triangled leaves of the white birch. This tree has other marked characteristics. "Notice the bough where it joins the white trunk; this triangular brown patch below the branch is always present in any tree of any age. The leaf stem is slender, rather long, and not downy; the leaf (often growing, as in my sketch, in pairs) is very smooth and shiny on both sides; also, the stem being slender the leaf shakes with the slightest breeze, and its varnished surface, reflecting the sunlight, breaks it into shifting, sparkling green fire."

Another series of sports may be studied in the leaves of the same tree, as the sassafras, of which three plainly marked shapes may be found on the same twig, and the mulberry similarly char-

acterized. A peculiarity of opposite style is presented in the leaf of the tulip tree, which is unique in shape, being cut off at the end and having a marked hollow or notch where nearly every other leaf is angular or convex.

Our space is filled, and we have said nothing of the pinnate leaves, or the spiny leaves, or the leaves of the spruces and firs, of all of which as interesting studies might be made.

FIG. 6.—RED MULBERRY.

The greatest sphere of usefulness which a tree occupies, Mr. Mathews says, is connected with its life. It is a great air purifier; it absorbs from the atmosphere the carbonic-acid gas which is poisonous to us; it holds and slowly dispenses moisture which the parched air needs; it gives out the ozone (or oxygen in an active electro-negative condition) which is peculiarly conducive to our health; and it modifies heat which would otherwise be overpowering. Each leaf is a builder up and an air regulator of a nature which is beneficial to us. "Its capacity for heat and sunshine is something astonishing. I have estimated that a certain sugar maple of large proportions, which grows near my cottage, puts forth in one season about four hundred and thirty-two thousand leaves; these leaves combined present a surface to sunlight of about twenty-one thousand six hundred square feet, or an area equal to pretty nearly half an acre. Every inch of this expanse breathes *in* life for the tree, and *out* health for man, while it absorbs in the aggregate an enormous amount of heat and sunlight. In time of rain it also holds the moisture, and allows it to evaporate by slow degrees when hot days return. The forests are vast sponges, which, through the agency of leaves, soak up the beneficent raindrops and compel them

to pass slowly through shaded channels to the parched lands beyond. It is indeed quite impossible to overestimate the value

FIG. 7.—TULIP TREE.

of the billions and billions of leaves which work and build for the benefit of humanity."

M. BERTHELOT reports to the French Academy of Sciences that the subscriptions for the proposed monument to Lavoisier, taken in France and other countries, amount to 47,353 francs, or $9,410. Of this sum, $100 are credited to the United States. The subscription is still open, and considerable sums are expected from particular sources, as the French Department of Public Instruction and the city of Paris; and the Emperor of Russia has headed a subscription list to be opened in his dominions.

THE EDUCATIVE VALUE OF CHILDREN'S QUESTIONING.

By HENRY L. CLAPP.

I KNOW intimately a little boy, now six and a half years old, who has been a persistent questioner since he was four. Thirteen months ago he began to read, and now reads The Youth's Companion, Alice in Wonderland, Lang's and Andersen's Fairy Tales, Kingsley's Water Babies, and Greek Heroes, school readers, and many other books with good understanding and excellent expression. As he has never been to school, and never has received a day's instruction in reading—that is, direct instruction, such as characterizes school work—his progress must be accounted for in some other way. Since it is not my purpose to describe in detail how he learned to read, I will simply say that it may be attributed wholly to persistent questioning on his part, being answered by his hearers, and having ample opportunities to practice what he found out. To this indirect instruction, excessively fragmentary and depending wholly upon his choice, there has been practically no limit.

When he was about four years old he would follow up his questions immediately with "Tell me. Why?" When he was five he introduced every subject he wished to talk about with "What do you think?" At six he dropped that, and substituted "Do you know what?" But, after two years and a half, he seems to entertain no thought of giving up "Tell me."

His favorite times for asking questions are when he is being dressed in the morning and at his meals. At other times during the day his questions occur at very irregular intervals, and only a few or one at a time. Sometimes he will read for an hour without saying a word, and then, when at play, will ask a question pertaining to what he has read. Often he will skip forward and back for fifteen minutes without speaking, and then ask a question about something upon which he has apparently been meditating. Frequently he sits at the table in silence for ten minutes, apparently taking no notice of conversation, meditating on some word or idea obtained from something he has read. It becomes evident, later, that he can carry on his own train of thought and at the same time hear and understand conversation, because he questions about both.

His mother used the word "disposed" at the breakfast table, but he seemed to take no notice of the conversation going on. At night, when jumping about the room for the mere pleasure of movement, he turned suddenly to me and asked, "What does 'disposed' mean?" One morning I heard him ask his mother

"Is there any key of C flat?" Not getting an answer, he continued: "I have asked you a good many times if there is a key of C flat. Tell me." The same morning, at the breakfast table, he suddenly introduced a very inappropriate subject with the question: "Do cannibals ever eat their friends? Tell me." "What made you think of that?" "I have heard people say that cannibals eat other people, and so I asked."

Most frequently his questions refer to some idea obtained from what he has read some time previously. For example: "What does *prudent* mean?" "Where did you see that word?" "In the story about the *Prudent* Farmer in Harper's Third Reader." "What does *verb active* mean?" "Where did you see that?" "In the story about Squeer's school, written by Charles Dickens, you know." "Is a merry heart better than wealth?" "Where did you read that?" "In Harper's Third Reader." "What does *effort* mean?" "Trying to do something. Where did you see that word?" "In the fable of the stork and the fox." "What is wisdom?" "Knowing many things. When a man has many wise thoughts he has wisdom." "Yes," he said, "wiseness." "Where did you see *wisdom?*" "I saw it in the picture of a door. Over the door was a card, and on the card it said, 'Wisdom is strength.' I saw a picture of somebody whispering in an owl's ear, and it said, 'A word to the wise.' Is the owl the wisest bird?" "What is honest milk?" This last question was suggested by his reading a milkman's circular.

On the other hand, many of his questions can not be connected with his reading, but appear to result from reasoning or a recognized analogy. "How do plants make themselves bigger when they grow?" he asked when we were talking about planting his garden. I heard him saying to himself, "Wildless, wildless." I asked him what he was talking about, and he replied: "About plants that are not wild. What are they called?" "Garden or cultivated plants," I answered. "What made you say wildless?" "Why," said he, "I knew that harmless meant something that wouldn't do any harm, and so wildless means plants that are not wild." He mentioned the fall, and I asked him what he meant by fall. He replied: "The winter at first, the first of it. Do they call it fall because everything is falling?" There was some talk about dressing him or putting on his dress, and, reasoning from analogy, he asked, "When God puts the skin on people, is that skinning them?" I once read of the people in the moon being like grasshoppers, and told him about it. When I had finished the story, he said: "When we look up in the sky we see the moon rolling on above us, and when the people in the moon look up in the sky they see the earth rolling along above them. What is the strange puzzle about that?" I told him that his specimen of

mica was silicate of potash, and he asked, "Why is mica silicate of potash? Because they put ashes in a pot?"

These questions have been recorded to represent an innumerable number unrecorded, and to show the wide range of thought and the variety of reasonings that a child under six years of age may have. They show his natural method of acquiring knowledge, but they can only suggest the ceaseless activity of his mind during all his waking hours.

His habit, to a greater or less degree, is the habit of all children. Very early, even before they begin to talk, they manifest a desire to know the causes of things; and they continue to show natural curiosity until they go to school, which they seem to recognize as a place where curiosity is very much out of place, since so little opportunity is given for its exercise. In that case curiosity is apt to be replaced by laziness and apparent dullness.

Out of school they are, with rare exceptions, very thoughtful and exceedingly busy about something. They question much for the satisfaction which they experience in finding reasons or explanations of various acts. Each questions from his own point of view, and thereby increases his understanding and develops his own mind. These voluntary questions engage his whole attention; they are for the time of the highest interest to him, and, on that account, of the greatest importance to his proper mental development. As he leaps about for the mere pleasure of physical movement, his thoughts also dart about among scenes past and present, and imagination carries him on to the future and back again like a flash. What pleasure he takes in these mental and physical movements when he is at full liberty to do as he pleases! He is happy because he is fulfilling the laws of his being, developing his mind and body by his own self-activities. He can not help questioning any more than he can help jumping or thinking.

In a proper home there is only moderate restriction on any of these means of development, and accordingly he develops there very fast. In the fields and woods also there are no restrictions on natural development. Running in the fields, climbing trees, and playing games of all sorts are powerful developing processes. Queries are rapidly formed and as rapidly answered, probabilities are balanced, decisions are made, and bodily movements follow in exact conformity to the judgment and will.

The moment children step into the ordinary schoolroom opportunities for questioning and spontaneous judging and willing are cut off. They are now going to be trained and developed by a logical, systematic, step-by-step method, frequently called normal. All physical movements with any vigor in them must be regulated by a minutely detailed system of gymnastics, which frequently comes to be so dominant that all natural play at recess

must give way to marching and countermarching. In the schoolroom questioning, judging, willing, and spontaneity in general seem to be vested in the teacher alone, to be incompatible with his idea of pupils' right thinking. The educational code there is, "Sit still, ask no questions, learn and recite your lessons, and do what I tell you." This ancient code makes the conditions favorable for the application of questions assumed to be asked after the Socratic method, in which as practiced the pupils' self-activities appear to be very much overlooked.

The universal method of teaching is catechetical, the teacher asking all the questions and the pupils attempting to answer them. The teacher sets the conditions and makes all the attacks on ignorance, negligence, and incompetence, and may be said truly to be on the offensive always; while the pupils constantly attempt to comply with conditions, repel attacks, and conceal their shortcomings, and may be said as truly to be always on the defensive. The mutual relations of teacher and pupils may be quite accurately determined by averaging the conditions which the graduates of various schools remember to have existed when they went to school. How they outwitted the teacher forms a bright spot in the memory. It is long remembered and easily recalled. Like a good joke, it is delightfully piquant and suggestive of similar jokes.

The customary one-sidedness of teaching makes school work more or less disagreeable and progress comparatively slow. It is difficult to excite and sustain interest. Repression, coercion, and machinery become necessary to make the government respected and respectable. Strong disciplinarians rather than good teachers are required when children's activities, either of body or mind, are directed into hard, unnatural channels or are kept down by forcible means. The teacher questions, struggles against the constitution of her pupils' minds, and really dominates them at last. Herbart says, "Tediousness is the greatest sin of instruction." The pupils often feel that their work is uninteresting and difficult without knowing why or how to help themselves; and they learn, often by bitter experience, that it is discreet to obey and learn and recite their lessons, however distasteful they may be. That is the traditional way—the way passed over by their parents, in which they are expected to go, and by which the torrent of their impulsive questions must needs be dammed up for many a long year in the future as it has been for centuries in the past. *Repression* is the word naturally and correctly applied to such a system.

Children's natural, constant, and almost irrepressible desire to question freely about everything that comes within the range of their experience has not been considered of any special value

in educating them. Even Froebel seems to have overlooked its great value as a means of developing reason, judgment, the relation of things, and everything that makes for real knowledge. Out of school it has room. A man may question everything, past, present, and future, but a child's inalienable right to say "Why?" out loud in a schoolroom is hardly recognized. He is to take instruction without question. Traditions in education are almost unchangeable.

Children, as a rule, do not like to be held to a definite line of questioning by a teacher, unless the subject is very interesting by nature. The impressive, commanding, magnetic teacher may have no apparent difficulty in holding the pupils to her questions; but pride in that feat partakes strongly of vainglory. What will they do when left to themselves? What can they do without her? How far can they go alone? To what degree are they self-controlled. Fine instruction has value, but teaching pupils to teach themselves, and simply and skillfully directing their self-activities to that end, is a great deal better. Herbert Spencer says, "Bear constantly in mind the truth that the aim of your discipline should be to produce a *self-governing* being, not to produce a being to be *governed by others.*"

President Eliot says: "All teachers who deserve the name now recognize that self-control is the ultimate moral object of training in youth—a self-control independent of temporary artificial restraints, exclusions, or pressures, as also of the physical presence of a dominating person. To cultivate in the young this self-control should be the steady object of parents and teachers all the way from babyhood to full maturity."

There are a few schools in which the pupils feel free to ask questions, when it is necessary, in school time. In many schools there is a standing invitation to ask and answer questions *before and after school.* Such an invitation amounts to a prohibition of questioning. In many schools the pupils are trained to talk; but the substance of the talk is along the old line, reproduction, or a new form of recitation, better than the old, because in the pupils' own language. Nevertheless, training children to question in school time as a means of developing reason, power of comprehension, and self-control is scarcely appreciated anywhere. Even suggestions of children's questioning are exceedingly few in literature on education; but records of its actual practice are unknown. Two lines in Tate's Philosophy of Education and a few lines concerning the Jesuits' methods of teaching in Quick's Educational Reformers are all the suggestions that have come to my notice. The Jesuits divided their boys into two camps and had them question each other, to stimulate rivalry and emulation.

It will be readily conceded that teachers like to question

pupils and to show their skill in questioning. A good many so-called experts consider the ability of the teacher to question logically as the measure of his value. This is a very superficial view of the matter. It has resulted in positive injury to many teachers, and greater injury to more pupils.

Some teachers confess that they are disinclined to allow their pupils to question as a practice, since the questions may be pointless, illogical, and inadequate. That is precisely the kind of work which the school should undertake to remedy. The pupil's questions reveal the condition of his mind quite as much as his answers to the teacher's questions. His anxiety to avoid errors moves him to say what he thinks the teacher desires. When he questions he is thrown off his guard, and his misconceptions, and feebleness or acuteness of mind are revealed inadvertently and the teacher can help just when and where help is needed without undue interference, which is so common in school.

Moreover, these teachers claim that such freedom as this work necessitates might lead to disorder, or what passes for disorder in the opinion of those who judge the order by the degree of stillness and lack of movement prevailing. So they keep the reins taut in their own hands and set up a despotism of varying degrees of severity.

Many an inexperienced teacher, who has learned this method at some training school for teachers, may charge her failure in maintaining order to her persistence in trying to hold a large class of pupils to her questions. Her logical plans and orderly questions are commonly inelastic, unsuitable, monotonous, and sometimes irritating. She bends the wills of her pupils to her own; but there is too much elasticity in their mental habitudes to endure the strain long. In a few days the monotony of a single voice, hardly still during the day, and the vain attempt to "follow my leader" in her set and searching questions result in restlessness, inattention, and disorder. Her pupils can not readily get used to the one-sided game.

The aims which the average teacher finds the most difficult in reaching are, to secure attention, arouse interest, induce spontaneity, elicit independent thought, give enjoyment, and prevent ordinary school work from becoming or appearing a task. This difficulty also may very largely be charged to the traditional mode of questioning. There is seldom any enjoyment in it. Herbert Spencer says: "Experience is daily showing with greater clearness that there is always a method to be found productive of interest—even of delight; and it ever turns out that this is the method proved by all other tests to be the right one."

All teachers unite in extolling spontaneity in the abstract, but almost universally ignore it in their teaching by reason of alleged

difficulties in reducing it to practice. They are always talking about attention, interest, and independent thought, even to their pupils, while they are continually heading off the development of those desirable attributes by restricting their pupils to answering questions referring to tasks which they have set. Certainly their pupils seldom find "delight" in their questions, but, on the contrary, find comfort in evasion, as they very frequently say they understand the subject under question when they do not, in order to get rid of the galling questions which seem especially designed to reveal their deficiencies and bring about their disgrace.

Supervisor Martin, one of the keenest and wisest observers on the Board of Supervisors of Public Schools in Boston, says in his report recently issued: "If there be a general weakness, it lies in the failure to develop in the pupils the ambition and the power of self-help. The skill of the teachers is more fully exhibited in their presentation of subjects than in stimulating pupils to independent effort. Much of the work is simple giving and taking and giving back." Independent effort being generally wanting, spontaneity of necessity must be wanting, because there can be no independent effort where there is no desire or will to make it. In this regard probably the schools of Boston are no more deficient than schools at large.

But, in view of all the talk made at educational conventions during many decades, it is remarkable how little progress in spontaneity has been made in school, even since Froebel's time.

Froebel said: "I must not neutralize and deaden that spontaneity which is the mainspring of all the machinery; I must rather encourage it, while ever opening new fields for its exercise, and giving it new directions. Can I not then even now gradually transform their play into work, but work which shall look like play, work which shall originate in the same or similar impulses, and exercise the same energies as I see employed in their own amusements and occupations?" Pestalozzi also claimed that "spontaneity and self-activity are the necessary conditions under which the mind educates itself, and gains power and independence."

A careful distinction should be made between children's activities and self-activities, the one often being confounded with the other by teachers. Generally their activities in school result from a compelling force of will, of laws, of penalties, all of which are kept well out of sight in some schools, but in the immediate foreground in most schools. This compelling force is often necessary under present conditions, but not so often as practice would make it appear.

Generally teachers' traditions and scholastic training are no safe guides in dealing with self-activities educationally. Self-

activity is spontaneous, the result of an inside motive. How to teach children to desire to undertake and stick to school work, whether the teacher be present or absent, tradition does not state. To be sure, children's questioning in school as a real educative force and a rule of practice is, it may be, startlingly new; but any means, precedented or unprecedented, that will certainly result in spontaneous activity should be earnestly sought for and fairly used.

The idea of educating children through their activities has of late years found expression in giving them something to do with their hands, as seen in the various forms of manual training. The advocates and teachers of this work indulge the thought and give the impression that it brings out children's self-activities remarkably well. Many fondly believe that by means of it the "whole boy" is sent to school. Nevertheless, his self-activities seem to have but little more opportunity for development than before the doing era, advantageous as that really is. Children in all departments of manual training are taught, instructed, crammed, compelled, it may be, as of old, and then they work out the instruction with head and hand, whereas formerly the head only attempted to follow instructions, more often unsuccessfully. Certainly a great advance was made by the introduction of manual training; but spontaneous self-activity is not a leading motive in the work, if any at all. The work is prescribed.

The child's curiosity or investigating spirit does not receive its satisfaction in any form of manual training now in use. Individual experimentation and investigation have small place in it, so that the need of other educational forces is felt. The spirit of inquiry is much less apparent in school than out. Whose fault is it? Surely not the children's. Nature studies are doing the most to foster the spirit of inquiry, manual training hardly anything. Constructiveness is important, but no more important in education than investigation. Investigation and voluntary work are the expressions of self-activities, while prescribed work is the expression of activities governed by a temporary, outside, dominating influence.

In connection with manual training H. Courthope Bowen says in his work on Froebel and Self-activities: "Broadly speaking, Pestalozzi's plan is one of observing and *imitating;* Froebel's, one of observing and *inventing.* To exercise the *creative,* originating powers of the child is Froebel's main object; to teach the child to speak and to do work already prescribed is largely the aim of Pestalozzi. Froebel's plan, therefore, more directly tends to develop independence and originality of character." To carry out Froebel's plan children must have far more true liberty in thought and action in school than they now have. Their spirit and temper must

be reached if they are to be educated properly. Education must become less Pestalozzian and more Froebelian. So it does become when children question.

The idea of educating children through play, where self-activities are at their best, is not new, having been not only clearly set forth in theory but reduced to practice by Froebel. The only application of the play element as a means of development in our systems of education is found in the kindergarten. No one has shown how it can be made useful in schools beyond the kindergarten. To most teachers it seems utterly incompatible with the work of such schools. They are not willing to admit in any degree that "play is the work of the child." If the play element is of so high educational value in the kindergarten, why is it not of much higher value all along up through the elementary school, where the pupils play much more vigorously, intelligently, and skillfully? Even young men and women who give up so much for baseball, polo, tennis, and golf, prove that the play element abides long; and, although it now results in healthful exercise, and a development of body and mind that is too frequently and unwarrantably claimed as the result of school work, it might be turned to the account of school education if half the time and attention given to prescribed studies were given to it.

Full opportunity to ask questions in the schoolroom *in school time gives the play impulse* in children *an excellent outlet.* Their unique expressions and inadequate conceptions result in questions and answers that are not only instructive but decidedly entertaining to all concerned. They are often irresistibly funny without intending to be. On the other hand, there being ample room for the play of thought, the zest of play frequently runs through their exercises. When the teacher sees the need of comment or explanation, the attitude of their minds is exactly appropriate, and their attention spontaneous and perfect; never so willing and complete when the teacher talks, questions, reasons, prescribes, and compels. This judgment is not the result of a single, ephemeral experiment, but of demonstrations repeated through years.

Under the system of spontaneous questions and self-conducted exercises "blue Monday," so called on account of the apparent dullness of pupils on Monday forenoon, disappears with the apparent exhaustion on Friday afternoon. The opportunity to stand up, turn about, and use muscles and wills in a way that does not savor of militarism and gymnastics conduces to great activity and excellent temper. Appropriate conditions determine the spirit of all life and action.

The habit of asking questions puts the questioner in the attitude of an investigator and develops an active habit of mind. Always to be questioned induces waiting passivity, and the dif-

ference is radical and momentous for true education. In questioning lies the germ of original research; all inventions, discoveries, and progress have come out of it. Only the questioner becomes a discoverer. And since it is obvious—often disagreeably so out of school—that the questioning, investigating habit is the child's most marked characteristic, and the most direct manifestation of a constitutional current of mental action that can not be repressed long any way, and seldom without danger, it seems inexcusable that any educational agency worthy of the name should fail to develop so important a habit by every means possible. Its careful cultivation would be sure to result in such a success in original research as schools have never yet won.

Prof. C. S. Minot says, "To train men to originality in every field of production is the proper function of a true university." Prof. N. S. Shaler made essentially the same statement in the Atlantic Monthly. It is not likely that originality will be called out easily in the university when all through the primary, secondary, and collegiate education, fifteen years or more, it has been permitted to lie dormant. Men do not begin to train trees and vines of mature growth. If originality is to be brought to full fruition in life, its obvious beginnings as seen in children's questions and curiosity must be cherished most carefully, not only in the university, but in every school that leads to the university. Originality, like playing the violin, must be encouraged early, if proper development is to be attained.

Children like better to work or play in company with one another than with adults; and when so working or playing they do not lack for questions and answers. At their parties they play various mental games with much zest. There is no satisfactory reason why this play faculty should not be brought into the schoolroom everywhere as it has been in a few places, by means of pupils' questioning guided by the teacher.

Their questioning has been found especially valuable in all review work, in history, geography, language work, civil government, physics, mineralogy, botany, and mental arithmetic. In the last four studies the questions are nearly always new and *impromptu*.

In this work they find the required variety in questions and voices, they measure their strength with one another, their wit and fancy find expression in amusing and unexpected turns, and their diligent attention and mental alertness are constant. The freedom, pleasure, and exhilaration that are essential elements of the work lead pupils to do their best. Their exuberant spirits, energy, individuality, and originality find proper outlets, and, in consequence, their tempers are improved. They have time to frame and answer questions based on their own data, and a place for

"applying theory, or putting acquisitions into practice, and for personally using for productive ends their disciplined powers." So they learn to stand up unembarrassed, to lose self-consciousness, to think on their feet, to set conditions as well as comply with them, to lead thought as well as follow it, and get that real practice in adapting themselves to constantly changing conditions that will serve them so well when school life has ended. All this work tends directly to that most important acquisition, self-control in body and mind.

Perhaps the greatest benefit derived from mutual questioning is of an ethical nature, since it affords the best opportunity in school for the cultivation of the most refined human relations. The pupils become habituated to deference, self-restraint, politeness, kindness, unconsciousness of self, and equality of rights as regards time, attention, instruction, and opportunity to work without interference. Egotism, selfishness, plagiarism, the desire for display, and the struggle for personal rewards have little room for growth on account of persistent practice in ways that make for qualities of an opposite character. The teacher's illustrations from the workings of society and the administration of government find their appropriate places and are immediately put into practice in this genuine, embryo part of the body politic. The pupil's judgment is constantly appealed to. As teachers have said many times, the pupils seem like one great family, each member working for the common good. The educational value of the boy teaching the boy by simple language and blackboard illustrations is recognized. The reflex action of teaching is seen to be as valuable to the boy as to the teacher.

The ethical value of mutual questioning is especially noticeable in the pupil's graduating exercises, which are the legitimate results of their regular work. Each pupil has an opportunity to do according to his ability. There are no picked scholars, no exhaustively trained precocities, no survival of the fittest, no false show, no tragic or comic declamations or mere mouthings of the misty words of statesmen and poets; but each reveals his own thoughts in his own way, pruned and strengthened by his training. The ease, interest, energy, self-reliance, and politeness with which they carry on their impromptu exercises in the presence of five hundred people can not be understood by even distinguished educators, versed in traditional methods only, who may be present.

The doctrine of opportunity has not been preached enough, and the wonderful constitution of the mind and its power to develop itself by its own energies when fully aroused have been so often and so unjustly claimed as the direct results of systematic or dogmatic instruction that the truth, when held up to view, may not be recognized and acknowledged.

A fitting conclusion to this presentation of the educative value of children's questioning may be found in a brief mention of the children's own thoughts concerning the subject.

There having been no conversation or suggestions concerning the matter, the pupils who averaged fifteen years of age were asked to give their ideas of the advantages of questioning each other, and they expressed themselves thus: "We don't waste time, because if our teacher is out of the room we can go on with our recitation. Having to decide on the answers to our questions makes us think. We have to know more about our lessons if we ask questions than if we only answered them. We have more questions than if our teacher made them all. We are all of about the same age, and understand and misunderstand things in about the same way, and can help each other out. Questioning helps us to talk and obliges us to depend on ourselves. When thirty-eight children are making questions, some one of them may think of a question that the teacher may not think of. We look forward to conducting our graduating exercises without help from our teacher, and this work trains us for that."

THE SELF AND ITS DERANGEMENTS.

By Prof. WILLIAM ROMAINE NEWBOLD.

IN this and my succeeding paper I intend to take up a group of phenomena which involve some of the most perplexing of psychological and metaphysical questions. There is no problem that can be of greater interest to us as human beings than that which concerns the nature of my self, my origin, and my destiny. Of my origin and my destiny exact Science is not yet in a position to say much, and of my nature and constitution she knows little more. The greater interest therefore attaches to those cases in which the consciousness of self seems to be disordered, and, although we are far from a complete comprehension of them, we can go far enough to show that they present phenomena which are closely akin to those which we have been examining.

We may set aside at the outset the notion that the real self is an immaterial, invisible, indestructible something called mind or soul in which my mental states inhere. Whether anything of the kind exists or not I do not know; if it does, we know nothing of it, and it is not of the least significance except as a symbol for the indestructibility of the conscious self. The only self in which I have interest is the self that feels, endures, hopes, and the only self I can know is the self that is manifested in consciousness.

Setting aside, then, this notion of the self as mind or soul

apart from consciousness, there remains as the object of inquiry consciousness as we know it. In my first three papers (December, 1895, January and February, 1896) I have given my reasons for thinking that we may conceive of it as a web containing manifold and constantly shifting strands. Sensations of all kinds, some vivid and some obscure, memories, anticipations, emotions, and deliberate volitions succeed one another in bewildering confusion. Yet at any given moment this apparent confusion is in reality a system the form and constitution of which is determined by laws as inflexible as any that rule in the physical world.

What, then, is my self? Is it merely another name for the whole? Or are there parts of this ever-shifting, kaleidoscopic phantasmagoria which are parts of my self in a more special sense than the others?

I think there are. In the first place, and in the broadest sense of the word self, all those sensations which go to make up my consciousness of my body as distinguished from the sensations which I regard as springing from the outer world are peculiarly mine. The appearance of my body from without, the double sensations that arise from contact of part with part, but especially the vague sensations that are always pouring in from every muscle and joint, from the heart, lungs, stomach, and intestines, these all blend into a confused mass which forms the background or stage upon which the more distinct elements that are supplied by the special senses play their parts. Any changes in this mass I feel as changes in my self. Emotions and moods, and the indefinable difference between the feeling of health and the feeling of disease spring from obscure changes in it, but I feel them as changes in my self.

But with reflection comes a tendency to narrow the meaning of the word self. Who has not gazed in the mirror at what others call his self until the sense of opposition between the real self and that at which he was looking became so intense that he turned away almost frightened and glad to sink again into the old familiar sense of unity with his body? The more I reflect the less does my body seem important to *me*. *I* am the inner life of thought. Most of my thoughts I acknowledge as truly mine, and most of the deeds that spring out of them I recognize as belonging to me. But occasionally a thought appears toward which a sense of strangeness arises—it seems none of mine. Possibly because it is so much better than my usual thoughts that it seems like a breath from a higher world, possibly because it is so wicked that I am almost tempted to believe it comes from a devil, possibly merely because it is insistent and does not go when I bid it. So of the impulses and desires that control me. Most of them are mine, but now and then I do something toward which I feel, when

I look back upon it, a curious sense of irresponsibility, as if it were not of my doing after all. Such deeds are always those which I seldom do; my everyday virtues and my everyday vices I must admit are mine.

But there is just one thing which I always acknowledge as mine. It is the sense of effort. It matters not whether I employ it in contracting my muscles to the utmost, in fixing attention upon some uninteresting object, in following some distant end in spite of the solicitations of the present, or in overcoming for some moral reason the claims of the greater pleasure—this sense of effort I always acknowledge and always must acknowledge as mine.

The word self, then, seems to stand for the most frequently recurrent elements of my inner life, with the consciousness of effort as its very essence and core. But it is evident that we can not, whenever we speak of it, think all these things. To evade that necessity most men probably make use of some vague thought symbol which the word self suggests. Symbols of this sort are known as concepts. They play a great part in our mental life; without them the marvelous achievements of the human mind would never have been. Yet they are so shadowy and evanescent that it is almost impossible to determine their precise constitution, and the more complex and diverse the phenomena they stand for, the greater the difficulty of fixing and describing them. The task is almost as fruitless from the practical point of view as it is vain from the speculative, yet an immense amount of labor and ingenuity has been expended upon it. Most of the work commonly termed metaphysical is based upon the conviction that these shadows are or represent realities apart from the concrete things for which they stand; sundry attributes are ascribed to them, and out of these imaginary attributes the metaphysician tries to construct a science. Most of the difficulties that attach to the notion of a self or ego spring out of this confusion between the symbol and the things symbolized, and I shall therefore say no more of the symbol, but confine myself to the concrete states of consciousness which constitute my thinking self and which alone possess interest for me.

If this analysis of the self be true, it will follow that the consciousness of self can be modified by the addition to or subtraction from my inner life of large masses of stable elements, and this appears to be borne out by the facts.

Extensive changes in the mass of bodily sensation are frequently accompanied by modifications in the sense of self. I can not go into this in detail, but those who care to follow the subject out will find it treated at length by Prof. Ribot in his little monograph, The Diseases of Personality.

Great changes in one's circumstances and surroundings are often connected with similar changes in the self-consciousness. A journey to a foreign land, the sudden death of a relative or friend, a great disappointment in love or in business, or an equally great and unexpected success—all these necessarily involve the demolition of many of one's most permanent habits, plans, and expectations. There may follow a period of confusion in which the self of the present moment looks back upon the self of the past as a very different being.

Analogous changes take place normally in the course of life with the constant addition of new experiences and development of new instincts. The sense of self usually changes imperceptibly to keep pace with these new growths, but sometimes the change can be felt. The young man or young girl sometimes notices it during or at the close of the period of adolescence, and we frequently become conscious of it at other times, when something brings very clearly to mind the events of years ago. Not long since I ran across a book over which I used to pore as a child, but had not seen for years; when I opened it, my present self for just one moment fell away, and I was again a child of eight. It was a strange experience, and the childish self that then for a second or two lived again was much more unlike the present *I* than I commonly think of it as being.

If our memories are constituent parts of our self-consciousness, it follows that any extensive abolition of memories will impair or destroy a man's sense of self. This is so common a phenomenon that I need not quote illustrations. More interesting are those cases in which certain portions of a person's memory are abolished and restored at varying intervals, especially when illusory memories and other delusions are commingled with the memories that remain. In such cases we get true modifications of the patient's personality. One of the best known of these cases is that of Ansel Bourne.*

Mr. Bourne lived in a village near Providence, R. I. On January 17, 1887, he went to Providence, drew five hundred and fifty-one dollars with which to pay for a farm he intended to buy, and then disappeared. About two weeks later he appeared in Norristown, Pa., styling himself A. J. Brown, rented a room, divided it in two by curtains, lived and slept in the rear room, and opened a little shop in the front for the sale of toys, confectionery, notions, etc. During the six weeks he lived there no one noted anything unusual in his demeanor.

"On the morning of Monday, March 14th, about five o'clock, he

* This account is abridged from Dr. Richard Hodgson's paper, A Case of Double Personality, in The Proceedings of the Society for Psychical Research, vol. vii, pp. 221–257.

heard, he says, an explosion like the report of a gun or a pistol, and, waking, he noticed that there was a ridge in his bed not like the bed he had been accustomed to sleep in. He noticed the electric light opposite his windows. He rose and pulled away the curtains and looked out on the street. He felt very weak, and thought he had been drugged. His next sensation was that of fear, knowing that he was in a place where he had no business to be. He feared arrest as a burglar, or possibly injury. He says this is the only time in his life he ever feared a policeman.

"The last thing he could remember before waking was seeing the Adams express wagons at the corner of Dorrance and Broad Streets, in Providence, on his way from the store of his nephew in Broad Street to his sister's residence in Westminster Street, on January 17th. He waited to hear some one move, and for two hours he suffered great mental distress. Finally, he tried the door, and, finding it fastened on the inside, opened it. Hearing some one moving in another room, he rapped at the door." His landlord opened it, and from him he learned where he was, how he came there, and what day of the month it was. The landlord thought he was insane and sent for a doctor, and the doctor telegraphed for his relatives and had him taken home.

Prof. James, of Harvard, and Dr. Hodgson heard of this case about three years later, and got Mr. Bourne's consent to their investigating it. Prof. James hypnotized Mr. Bourne, with the hope of reviving the Brown state, and was surprisingly successful. He told the story of his wanderings correctly, giving clews to his doings during the two weeks that elapsed after he left Providence and before he appeared in Norristown. Of his own history he could tell very little. Said he: "Seems as if I was sot right down there in Dorrance Street without knowing where I came from. Got into a spot, don't know how I came there, both ends are blank." His name, he said, was Albert John Brown. He was "born in Newton, N. H., July 8, 1826 [he was born in New York city, July 8, 1826], had passed through a great deal of trouble, losses of friends and property; loss of his wife was one trouble—she died in 1881; three children living, but everything was confused prior to his finding himself in the horse car on the way to Pawtucket; he wanted to get away somewhere—he didn't know where—and have rest. . . . He had heard of the singular experience of Ansel Bourne, but did not know whether he had ever met Ansel Bourne or not. He had been a professor of religion himself for many years, belonged to the 'Christian' denomination, but back there everything was mixed up. He used to keep a store in Newton, N. H., and was engaged in lumber and trading business; had never previously dealt in the business which he took up in Norristown. He kept the Norristown store for six or

eight weeks—how he got away from there was all confused; since then it had been a blank. The last thing he remembered about the store was going to bed on Sunday night, March 13, 1887."

Some of these statements are true and others are not. He was never in Newton, N. H., in his life, and never engaged in any kind of trade. He had been a carpenter, farmer, and itinerant evangelist. His first wife did die in 1881, but he had married again; of his second wife the Brown personality never had any knowledge.

The nature of this change of personality is now fairly clear. The greater part of Ansel Bourne's memories were obliterated; the few that remained had lost all organic connection with one another, and gave rise to illusions of memory. Probably his new name and his notion that he had engaged in the lumber and trading business sprang from confused recollections of his own name and of his trade as a carpenter. But there was no material change in the active side of his nature. His character and instincts remained pretty much what they had been before. Further inquiry showed that he had had several epileptiform "fainting fits" within the last few years, and had been early in life the subject of a sudden loss of sight, hearing, and speech, followed by a "miraculous" cure.

Another typical case is that of Félida X——. This girl was first seen by Dr. Azam, of Bordeaux, in June of 1858. She was then about fifteen years old. About two years before hysterical symptoms had appeared; between her fourteenth and fifteenth years, at intervals of four or five days, and especially after some emotional excitement, she would feel a pain in the temples, followed by overpowering drowsiness. After an apparent sleep of ten minutes or so she would awake in a secondary state. It would last an hour or two, and then she would pass into her ordinary condition through a period of unconsciousness, as before.

In the primary state she was perfectly sane, was intelligent, resolute, and diligent, but taciturn, gloomy, even morose. She was not affectionate, was inclined to dwell upon her condition, and suffered much from pains of obscure origin. In the second state she was gay, hummed a tune over her sewing, was quick of movement, vivacious, fond of visiting, was emotionally sensitive and generally flighty. Her pains were much better. In her first state she remembered all her childhood and what had happened during other occurrences of the same state, but nothing of the second. In the second, however, her memory was complete, embracing the first as well as the second. She then spoke of her primary condition as her "attacks" (*crises*) or as that "stupid state" (*cet état bête*). Occasionally a third state made its appearance. The transition was as above described, but in it she seemed

mentally confused, was the prey to intense terror, saw horrible visions, etc.

She married when between sixteen and seventeen years of age, and Dr. Azam lost sight of her for sixteen years. In 1876 he hunted her up again, and had kept her in sight until the appearance of his book in 1887. Considerable changes have taken place in her condition. The transition states are much shorter, being scarcely noticeable. Her second state has continuously gained ground upon her first, so that in 1865, ten years after its first appearance, her life was about equally divided between them. In 1875 the first only recurred at long and irregular intervals and lasted only a few hours. In 1887 its recurrences were rarer and shorter still. Throughout her life she has been a hysteric of the worst kind. She had had her sensations of touch, taste, and smell impaired, she had had frequent hæmorrhages from the nose, lungs, and stomach, and when excited had convulsive attacks. On one occasion she had a hæmorrhage from the scalp. Red spots often appear on the left side of the body and are accompanied by pain and heat, frequently by swelling. One such swelling on her hand burst her glove. The third state, that of panic terror and mental confusion, has become much more frequent and lasts longer. With advancing years and troubles her second state has become less gay and careless, so that the contrast of character is not so marked, but the gulf in her memories remains as wide as ever. She went to a friend's funeral in the second state; on her way home she passed into the first and could not imagine what brought her into a carriage full of mourners. Her sister-in-law died after a long illness; Félida passed into her first state and knew nothing of her death, but, remembering her illness, inferred that she had died from the mourning garb in which she found herself clad. Once in her second state she grew jealous of another woman and tried to hang herself, but was cut down in time by her neighbors. When she recovered she expressed the wish to go into her first state, for then, she said, she would forget her misery. And she did, for the next time she passed into it she showed herself most affectionate to the former object of her jealousy.

The changes that take place in Félida's case are more far-reaching than those of Ansel Bourne. Not only are large blocks of memories erased, but the active side of her mind is profoundly affected. Yet one would scarcely say that the two Félidas were different people. Rather does it seem that the real Félida is the second, the one which first came to light amid the changes of adolescence. It is like Ansel Bourne's case reversed, for A. J. Brown is Ansel Bourne shorn of nearly all that was his; the second Félida is the first Félida completed by the addition of much that was her birthright.

I have already alluded to the fact that Ansel Bourne early in life suffered a sudden loss of sight, hearing, and speech, and as suddenly regained them; and in the case of Félida I also alluded to her hysterical condition and to her third state. Now, all these phenomena from the purely psychological point of view belong under the same category. The sudden splitting off from the true Ansel Bourne of a mass of states and tendencies which took a new name and called themselves a new person is precisely analogous to the equally sudden splitting off from Ansel Bourne's consciousness of his powers of sight, hearing, and speech. In my first three papers I have developed at length the conception of consciousness as a co-ordinated system capable of greater or less dissolution or disordination without the destruction of its component elements. These two cases are illustrations in point. In both the period of complete disordination or "unconsciousness" was very brief and was followed by a recombination of the elements which had formerly constituted a personality into a distinctly new system, which in one case assumed a new name. In Félida's third state we have a third recombination of some of these elements, but it is apparently very imperfect, for it is accompanied by hallucinations, and hallucinations depend in large measure upon defective co-ordination. In the case of A. J. Brown the new system seemed relatively quite stable, for it was evoked three years afterward by simply disordinating Mr. Bourne's consciousness. Yet in its later occurrences it appeared to be disintegrating.

I have spent a good deal of time upon these three cases because their relative simplicity, their similarity, and the care with which they have been observed make it easy to form a conception of the way in which the successive states were related to one another. The next which I shall take up does not differ from these in kind, but is much more complex. In it we see the patient's memory-store split into at least five groups, among which the use of his sense organs and muscles is repartitioned in a most curious manner, while his character presents in each state certain distinctive traits.

Louis V—— was born in Paris, February 12, 1863, of a dissolute and hysterical mother and an unknown father. Even in his early childhood he was hysterical, had hæmorrhages from the stomach and transient paralyses. His mother maltreated him, and he became a vagabond. At eight years and a half he was committed to the house of correction at Saint-Urbain. His health was fairly good until March 23, 1877, when he was frightened by a viper, which wound itself around his arm while he was gathering wood. That night he had a violent attack of convulsions; when they passed away, his lower limbs seemed permanently paralyzed. His character was gentle and timid. Three years later he was

transferred to an asylum at Bonneval, where he was taught the trade of a tailor. After two months he had a convulsive attack which lasted fifty hours; at its close the paralysis had disappeared and with it all recollection of the past three years, including all that he had learned in the tailor shop. His character and tastes had also changed. He had become quarrelsome, greedy, and rude. Formerly he did not like wine, and used to give his allowance to his comrades; now he stole theirs whenever he could. He robbed a fellow-patient and escaped; when recaptured he fought savagely with his captors. In June, 1881, he was released as cured. For the next three years and a half he spent the greater portion of his time in insane asylums in various parts of France. In January of 1885 he escaped from the Bicêtre in Paris, where he was then confined, made his way to Rochefort, and enlisted in the marines. He was soon arrested and convicted of theft, but was thought to be insane and was sent to the asylum. There he fell into the hands of Professors Bourru and Burot, of the medical school at Rochefort. With infinite pains they recorded his condition, traced out his past history, and in their little book, Variations de la Personnalité (Paris, 1888), have given us a very careful analysis of the phenomena which he presented. After his release from Rochefort, Louis V—— was studied by other alienists, especially by Dr. Mabille, of La Rochelle, and Prof. M. J. Voisin, of the Salpêtrière.. Of late years his health has improved and many of his strange symptoms have disappeared.

The case is too complex to be given at length; a brief outline must suffice. MM. Bourru and Burot found that his conscious existence seemed split into at least five major states, in some of which several minor ones might be distinguished. In each state he remembered certain portions of his life, possessed certain sensations, had control of certain groups of muscles, and manifested certain traits of character. Each state could be induced in two ways: (1) By applying an electric current, magnet, or some substance—such as a bar of soft iron or a piece of gold—to a definite portion of his body; (2) by suggestion. Later Dr. Mabille discovered a third method of induction: by pressing upon certain groups of muscles he could cause them to become rigid, and then the patient passed into that state in which those muscles were regularly rigid.

Of these five states, the most important—that is, the one in which he approached most nearly to the normal—could be produced by applying a bar of soft iron to the right thigh. In it he was free from paralysis, and the strength of his arms was nearly equal, but his left side was abnormally sensitive. His character was that of an agreeable but commonplace young man; his language was correct; he could read and write fairly well. He re-

membered the greater part of his life, but forgot the periods during which he had been in other states.

Of the four other states of which I shall speak, the first three are marked by paralysis, sometimes accompanied by contracture, of the left side, right side, and lower half of the body, respectively; in the fourth he is free from all paralysis. With the paralysis the sensations of the paralyzed portions, including those of the special senses, are diminished or abolished.

When paralyzed on the right side he is excitable, violent, and impertinent; smokes all the time, and bothers every one with demands for money or tobacco. His speech is thick and almost unintelligible. He fawns upon those who are kind to him, but if crossed in the least flies into a rage. He professes himself an atheist and ultra-radical, and desires to kill those who exact of him tokens of respect. He either boasts of his thefts and justifies them or denies them altogether. He remembers very little of his past life, but, so far as it goes, his memory is excellent. He lives chiefly on milk.

Applying a magnet to the right arm causes difficulty in breathing, anxiety, mental confusion, slight movements on the right side; then the paralysis, anæsthesia, etc., all pass to the left side. His character is absolutely reversed. His speech is correct; he is gentle and polite; he thinks himself too ignorant to have opinions on questions of politics or religion. He no longer drinks milk at all. Of his former life he remembers only those fragments in which he was paralyzed in the same way.

Upon applying a magnet to the nape of the neck, the paralysis and anæsthesia pass to the lower half of the body. He is depressed; his speech is childish; he can barely spell the simplest syllables. He is stupid, and can not give his age correctly, but he can sew quite well. His memory covers those three years only during which his legs were paralyzed and in which he was taught the trade of a tailor.

Upon passing an electric current through his body, or applying a magnet to the top of his head, a fifth state is produced. He is free from all paralysis, and finds himself transported to the day when he was frightened by the viper. His muscular strength is about two thirds what it was in his first state; his character is that of an amiable little boy of fourteen. While in this state he fell asleep and dreamed aloud of his days at the reform school, telling a lazy companion that he ought to be grateful to the kind superintendent, and try his best to escape the vagabond's life which was otherwise in store for him. For his own part, he said, he was grateful to the judge who sent him there; he was sick and ignorant then and would have been lost, but now he proposes to lead an honest life of labor. The doctors tried to keep him in

this state and bring him gently to a consciousness of his true situation, but he soon fell into a convulsive attack and passed out of it.

I have no comments to make upon the reported efficacy of magnets and other physical agents in producing these phenomena. Most neurologists maintain, I believe, that they act only through suggestion, but a few claim that they have in some cases a specific effect. I have never seen any such phenomena myself, but the evidence is strong and the field seems to me one of the most promising for psycho-physiological investigation.

Quite apart from that, there can be no doubt that this constant shifting and redistribution of the elements of Louis V——'s personality rest at bottom upon a physiological foundation. Especially significant is the impairment of speech, when the paralysis was transferred from the left to the right side. The right side of the body is controlled by the left hemisphere of the brain, and *vice versa*. Now, it is known that in right-handed people the organ of speech is situated upon the left side of the brain. If these phenomena were wholly dependent upon suggestion, the patient's mental symptoms would correspond to what he thought they ought to be. But he would scarcely know that a right-sided paralysis ought to be accompanied by disorders of speech. It seems to me quite certain that in one of these states the right hemisphere was chiefly active and in the other the left; it is fair to infer that his other states depended also upon the functioning of definite portions of his brain, although one can not specify what those portions were.

Mr. F. W. H. Myers, in commenting upon this case,* conjectures that possibly in all of us the right hemisphere is less highly evolved than the left, and that, "just as certain of our visceral arrangements retain the traces of our prehuman ancestry, and just as our dextro-cerebral speech centers are often stammering, childish, or wholly inefficient, so also our dextro-cerebral 'character-forming' centers—the centers which on that side of the brain sum up or represent our highest activities—may retain, in their inferior evolution, traces of that savage ancestry which forms the somber background of the refinements and felicities of civilized men."

Louis V——'s states, although more complex than those of Félida X—— and Ansel Bourne, do not differ from them in kind. In all we have an apparent dissolution of the conscious self and the reconstruction of its elements into a new form. But one of these forms calls for special comment. In his last state Louis seemed to have fallen back into the condition in which he was

* Proceedings of the Society for Psychical Research, vol. iv, p. 23.

eight years before. This is more than a reconstruction of elements; it involves the revival of much that we usually suppose to be irretrievably lost. If such a recrudescence of the old childish self is possible, we must suppose that the growth of the brain is carried on like that of an onion, layer upon layer. Of course, I do not mean this literally. I merely mean that those portions of the brain which were active in childhood, the activity of which constituted my self of that period, may exist years after they have been disused, and then suddenly be brought into action again. Many such cases have been reported. The patient is described as literally relapsing into childhood; her thoughts, memories, desires, acts, even her writing, are those of her former childish self. It is claimed by others that there is no true relapse into childhood; the patient merely acts the part of a child according to her present notion of what she used to be. I have no doubt myself that it is possible. If A. J. Brown could lie dormant for three years under Mr. Bourne's skull only to revive the moment Mr. Bourne was hypnotized, I see no reason why our childish selves may not also survive, and in some cases there is good reason to think they have done so. But most of the cases reported are susceptible to the other interpretation, and, as it is the most simple and natural, I would resort to it whenever possible.

In my next paper I shall take up those derangements of personality in which there seems reason to believe that the secondary system does not wholly perish upon the reconstruction of the first.

EXAGGERATION AS AN ÆSTHETIC FACTOR.

By M. F. REGNAULT.

EXAGGERATION is a natural tendency of our minds, and the fact is recognized by every psychologist. Yet, when we study human thought and action, we forget the propensity to exaggeration and exercise our ingenuity in accounting for seemingly odd social facts which could be readily explained by applying this principle. There are not, perhaps, any branches of human activity in which the tendency to exaggerate is not marked. We might observe its effects in all branches of science if we should bring them up one by one. In history, persecutions and revolutionary disturbances have resulted from the exaggeration of an idea which may have been just in itself, but, taking possession of the mind, it assumes an absolute character, while nothing intervenes to counterbalance it; and, acting under the domination of an exclusive preoccupation, men commit deeds of a most astonishing character. In linguistics, the influence of the same prin-

ciple may be seen in the transformation of languages, through the prevalence in certain classes of society of the affectation of peculiar pronunciations. So the investigator, having discovered and proved a fact, tries to generalize it and magnify its importance; and sometimes he is able to make his contemporaries participate in the error. Yet the exaggeration is occasionally justified, and then occurs one of those great discoveries that mark new eras.

I shall not go into all these questions, but shall examine simply the part played by exaggeration in our idea of the beautiful; nor shall I consider whether, as some philosophers believe, there is an ideal of beauty—a beau ideal—outside of and above us, but shall confine myself to the illustration of the conceptions of beauty exhibited in the customs of the various races of men.

When we look at the ornamentation of costumes, for instance, and at devices for enhancing personal appearance, we find that they have been carried so far as to provoke mutilations. The negroes of Africa, strongly differentiated as they are from other races, are prone to exaggerate the peculiarities of their physiognomy. With lips already thick, some tribes stick thorns into them to provoke irritation and cause them to swell out still farther. The Wolowe women of the Senegal have learned to increase the prognathism or projection forward of the upper jaw. According to Faidherbe's description of the process, "as soon as the girl child's first incisors have appeared, they are extracted with a pair of pincers, and when the second begin to come out they are forced by a continual action of the lower incisors and the tongue into a forward direction." The negro women of the shores of Lake Tanganyika, to make their breasts larger, cause them to be stung by ants. The women of the Assinians of Guinea are, according to Mondière, still more ingenious. It is a sign of beauty among them, he says, to have the largest possible nipples; and "children of five years, as well as larger ones, may be seen hunting the nymphæ of the *Myrmidus fornarius* and pulling at their breasts while the insects bite them, to make them swell more quickly."

The negroes are also proud of their woolly hair, and some of them go so far as to build an enormous structure on their heads. Travelers say that the plaited headdress of the young women at Jenna, in the valley of the Niger, looks like a dragon's crest. The same custom prevails in Oceania among the Fijians, who have woolly hair too, and wear coiffures measuring as much as about five feet in circumference.

Many peoples—Malays, Kirghis, Hottentots, Namaquas, Bushmen, Brazilian Indians, and Society Islanders—are addicted to the practice of flattening their noses, and sometimes, as in the case of

the Hottentot Venus, they break the bone. On the other hand, peoples who have thin noses can never get them aquiline enough. Persians cultivate this shape by pressing the sides of the nose, and the custom existed in France in the sixteenth century.

Paint, by which the appearance of the features may be modified at the least cost, is much used by all peoples. Sometimes it is employed to extend the beard. Aino women think it a fine thing to have a mustache, and by this means give themselves a full one. Opposed to them are the American Indians, who, being almost beardless, pull out the few beard hairs they have.

Black eyes and thick eyebrows are highly esteemed in the East, and the women use kohl for the production of the desired effect. The ancient Egyptians were fond of large, almond-shaped eyes, and produced the appearance of them by painting a prolongation of the outer commissure of the eye. The custom prevailed widely, and is represented in all the sculptures. The Japanese, too, like almond eyes, but want them oblique, and secure that appearance in the same way, only giving a different direction to the stroke. This particular custom has disappeared from among other peoples, but the use of paints still continues, and we paint our lips rosy and blacken our eyebrows.

The origin of these practices is evident. There are others the motives of which are more debatable, but are elucidated on comparison with these. We mention especially the atrophy of the feet among the Chinese. Some have attributed it to the jealousy of husbands, or to regard for a queen who lived many centuries ago and was lame; but Malte-Brun and Ploss say that the Chinese naturally have small feet. Their women have sought to exaggerate this ethnic characteristic.

The object, in the examples we have cited, has been to accentuate a characteristic of the race. In other cases man exaggerates the weight or the volume of an ornament assumed originally for another purpose. According to Herbert Spencer, the ornament was primarily a sign of distinction. It was worn in a conspicuous place as a testimonial of a successful hunt or of a victory over the enemy. Savages still hang human teeth or the claws of wild beasts from their noses, lips, and ears. The Chibchas wear in this way chains formed of as many golden feathers as they have slain enemies.

The next step is to increase the volume and weight of the ornaments. Under the spur of emulation the ear lobe, for example, is loaded down with trinkets till it is stretched so as to touch the shoulder. The enlargement of the ear lobe then becomes the desirable thing to the savage, and his chief effort is to bring it about. Under a like perversion of taste, similar effects are produced with the stick inserted into the thick of the lips. In this

way some peculiar features of mutilation hitherto obscure to ethnologists are reasonably explained—deformations practiced in all the quarters of the world by diverse peoples in no way related to one another, but urged by the same thought arising spontaneously in their minds. The value of the object inserted in the ear, lips, or nose varies according to the wealth of the wearer. The rich use something that is considered precious, as alabaster, rock crystal, or ivory among different African tribes; while a poor man contents himself with a disk of horn or metal, or even a simple rolled leaf. The more wealthy he is, the heavier is the ornament and the more accentuated the deformation. While attention has not been particularly directed to this point, some travelers have noticed that the degree of mutilation varies in the same people according to the coquetry, wealth, or rank of the person. Sometimes the fancy runs to enormous bracelets and rings, the Bongo women wearing such ornaments weighing twenty-five kilogrammes. These shackles of enormous weight have been interpreted by some sociologists as reminiscences of slavery; Park Harrison supposed that the enlargement of the ear lobe was an offspring of sun worship; and other authors have invented a desire to resemble venerated animals as the prompting motive for mutilations.

Of kindred character with the deformations already described are those due to a desire to show that the subject is not obliged to work for his living. The mandarins and *literati* in Annam and China let their finger nails grow long and inclose them in sheaths. A similar custom exists in Polynesia and some parts of Africa. Fatness is a mark of woman's beauty and signifies ease and wealth in Uganda and among the Tuaregs. In contrast to these, the Javanese are proud of extreme thinness, and eat clay to produce it. This is an exaggeration of a characteristic of their race, for they are naturally slender.

Whatever is the fashion comes from the principle of exaggeration, and our clothes are shaped according to the same law. It is not more ridiculous to stretch the ear lobe till it lies on the shoulders than, as was done at the end of the fourteenth century, to wear shoes with toes so long that the ends of them were tied to the knee; or to wear the enormous ruffs of the reign of Henry III of France, and those structures which nearly doubled the height; or the headdresses of the time of Louis XIV, or the extravagant crinolines of thirty years ago.

We look upon the ways of our ancestors as ridiculous and incomprehensible, without considering that we are acting very much like them. We often meet at parties and balls persons who go beyond the present fashion, some exposing more of the shoulders, and some wearing more pointed shoes. A fashion modest in

the beginning is made absurd by a continued course of exaggeration. We never reach the most extravagant form in the beginning, but it is the culmination of a series of modifications becoming progressively more accentuated. Thus, the long-toed shoes were the growth of more than a century. The point began about the middle of the thirteenth century, reached its longest at the end of the fourteenth century, and disappeared all at once in 1420, when it gave way to the square-toed shoe.

The influence of exaggeration in forming the ideal of beauty is illustrated, too, in the art of different peoples. One of the elements of a Siamese woman's beauty is, according to M. Léon Rosny, an arched shape of the eyebrows, causing them to resemble crescents; and if we examine photographs of these women we shall find that the curvature of the eyebrows is indeed more marked in them than in their neighbors, the Annamites and Burmese. This feature is much exaggerated in their statues, and is most strongly indicated in the Buddhas in the *Musée Guimets*. The Hindus are even more slender and tall than Europeans, and admire a full pelvic development in women. While we have tightened our corsets to increase the appearance of slenderness and heighten the contrast between the waist and the hips, our admiration for classic art has prevented our carrying these exaggerations into statuary; but the Hindus have not refrained, and their works therefore have a very peculiar character.

The Siamese and Hindus, however, are not highly esteemed as artists. We will now, therefore, take some examples from a people in whom the high excellence of this faculty is undisputed—the Japanese. While their designs are usually very various, when they come to depict feminine beauty they exhibit a single type, which we find identical on all the "Kakemono." It is a strange kind of beauty, with the face greatly elongated, the nose continuing the profile of the forehead, and the eyes excessively oblique; a beauty rare enough in Japan, where the plebeian woman's face is short and round, but which may be found in the patricians and in the courtesans of high rank. We can prove the exaggeration here by figures. In the Japanese photographs the line of the eyes forms an angle of from two to seven degrees with the horizontal. This is said by some authors to be only in appearance, but M. Regalia has proved its reality by measurements of the cranial orbits. In the Japanese drawings the line makes an angle of from thirty-five to forty-four degrees. A comparison of these with old drawings of the eighteenth century will show that the exaggeration has become much more marked in the present century.

The Grecian portrait seems the perfection of the human type to us, and artists copy it, although it is actually rare. In it the

line of the nose is more or less perfectly the prolongation of the line of the forehead. The hollow at the root of the nose is almost effaced, and the prominence of the nose is softened. The absolute Grecian profile would therefore be represented in a drawing by a single continuous line for the forehead and nose. Yet another condition is essential for obtaining the fine Grecian profile. The forehead should not be receding. This marks the distinction between the Grecian and the Egyptian profile. The artists who lived under the Theban dynasties represented the human profile by a single line for the forehead and nose; but the line was oblique, making the nose prominent and the forehead retreating. They simply exaggerated a race characteristic—as may be shown by examining the mummies or the fellahs of the present time.

Several theories have been offered to account for the Grecian type of profile. Its existence in the Hellenic race has been denied. The few Grecian skulls in our possession present it very rarely, but some of them incontestably approach it. It may have been more common in the aristocratic caste. We must certainly acknowledge that it was not common, but it does not follow that it did not exist. It may still be found, though not very often, at Arles and Marseilles; and I have perceived it in some profile photographs of Greeks of Asia Minor in the collection of the *Société de Géographie* of Paris. It has been suggested that the Grecian profile was hieratic, borrowed from the Egyptians, improved upon and transformed. It is true that the archaic Grecian sculptures, as at Mycenæ, display a profile with salient nose and retreating forehead, and that the type was persistent on many funeral vases. Grecian art may have imitated Egyptian in its beginnings, although it is believed now that the imitation did not play a very preponderant part in the matter. But when, at a later period, the artists created the special profile of their statues, they could not have been guided by reasoning alone. This would be opposed to all the observations on the subject made by other people. They may have designed it, but to do so they had to start from visual perceptions. A third supposition is that the artists exaggerated a type which they had opportunities of observing among their countrymen, especially in the aristocratic and literary classes. An examination of the ancient statues will throw light on this point. In studying the pictures of the great men of Greece reproduced in the *Iconographie Grecque* of Visconti, it will be remarked that a large number of them resemble the ideal type copied in the statues of the gods. In order to proceed with mathematical exactness we have measured the angle, the apex of which is the root of the nose and the sides a line drawn from that point tangent to the forehead (disregarding the projection of the sinus) and the prolongation of the line of the nose. We have ap-

plied this measurement to twenty-seven profiles of statues of celebrated men, passing by all that could not be certainly identified, and taking only those on which the name was engraved, and which bore evident resemblance to the figures on their medals. We likewise passed over mythological personages like Homer, Sappho, and others, whose existence is not fully proved, and kings whose features might have been idealized for the sake of flattery. The angle thus determined measures from seven to fifteen degrees on the master-works of ancient statuary, statues of divinities and heroes. Of the twenty-seven human statues measured, five had angles of fifteen degrees or less, seven of between fifteen and twenty degrees, eight of between twenty and thirty degrees, and seven of thirty degrees and more. A small number of these profiles, it will be observed, present angles not departing greatly from those of the statues of the gods. We do not establish a mean from these, for we recognize that the sculptor may have exaggerated in the case of subjects who presented marked profiles. It can not be objected that the artist sought to idealize these men of genius; for the purest profiles are not those of the most celebrated characters. Solon, Plato, and Socrates, who enjoyed so great fame, appear to less advantage than Hermarchus, Bias, and Epaphroditas, who were much less well known.

We can obtain a more exact conception of the special characteristic of these statues by comparing them with the figures in Visconti's *Iconographie Romaine*. The Romans all had a very convex nose with the root usually depressed; and a tangent could not be drawn from that point to the forehead, even if the projection of the sinus were neglected. Of fourteen persons examined, only four had that line tangent to the forehead, while it was secant on all the others. The Grecian bust, on the other hand, had it tangent, with only two exceptions. Furthermore, the angle is very open in the Roman busts, ranging from twenty-four to forty-eight degrees. It appears, then, that the Greeks, like other peoples, established their ideal type by starting with the real and exaggerating certain qualities.

In this study of exaggeration as an element of æsthetic art, I make no criticism, but rather place myself in the position of those artists who see in the ideal something beyond and above the real. This conception has been assailed. In the eyes of many, the artist should confine himself strictly to copying the real, and be nothing but the inferior rival of the photograph—or rather, perhaps, of the composite photograph, which gives the mean of the features of several persons by fixing them upon a single sensitive plate. When anthropologists recognize the merits of artists' canons, they regard them as the expression of the truth, because they represent the mean proportions of a large number of in-

dividuals. The camera is doubtless useful to beginners, and helps them to avoid great errors; but the artist has nothing to do with it; he takes his inspiration from Nature, and his canon will vary according to the subject he treats. A slender and nimble runner will not have the proportions of an athlete. Furthermore, the artist will put something of his own into his subject, exaggerating, usually without thinking of it, some features that have impressed him, and ignoring others.

Such departure from truth is not necessarily wrong. Exaggeration, like all our tendencies, may have a good or a bad result, according to the use that is made of it. We reprehend it when it develops unpleasant traits into undue prominence, or when it imprisons us in inconvenient and unseemly garments. But when it emphasizes among the traits of our countenance those which are associated with intelligence, bringing out the forehead which thinks, augmenting the facial reliefs upon which emotion is expressed, and retiring the merely physical features, it offers an attractive ideal and one that should not be despised.

We are not wrong when we admire the beauty of those among us in whom the characteristics of our race are exaggerated. They possess in the highest degree those features which are in course of development, they represent the generations of the future, and are worthy, by this title, to be perpetuated.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

ENRICO FERRI ON HOMICIDE.

By HELEN ZIMMERN.

SECOND PAPER.

FERRI passes in review 1,711 individuals, of whom 711 are soldiers, 699 criminals, and 301 madmen. In this minute examination of anthropometric data he discusses almost every case, pointing out its specific characteristics by means of ample comparisons, which justify his methods of research and his conclusions, as well as throw light on the difficult and not yet firmly established study of criminal anthropology. To close this section of his learned work, he devotes a portion to the reaffirmation of the inferiority of criminal as compared with normal man, and to the analogy that certain anomalies and delinquent characteristics present, deducing thence criminal degeneracy. Very remarkable are the differences of cephalometric characteristics between a certain number of soldiers examined, among whom were some students. The superiority of the latter was incontestably proved by the great anterior semicircumference of the head, by the greater

cranial capacity, by the larger frontal diameter, and the minor development of the upper jaw. Worthy of note, too, in regard to this last point is the result of the examination of homicidal murderers as respects recidivistry. The former showed less cranial capacity and a minor frontal diameter, while their upper jaws were more developed.

Having examined these chronic anomalies in criminals in reaffirming the conclusions arrived at by the modern school of criminal anthropology, Ferri gives us the physiognomy of murderers in their characteristic traits, calling to aid the help of photography. It is an interesting series of pictures that he has thus grouped together. Here is the apish type; there the half-mad; there one with large jaws, the most characteristic and frequent feature; the type with receding forehead, etc. The study of temperament and of race in the order of delinquency, which represents the bio-psychic personality of an individual and of a people, is not yet well matured, as opinions with regard to their influences are many and varied. Still, some progress has been made. Thus it is popularly held that full-blooded, passionate, energetic temperaments are more prone to homicide, while the truth really lies in the opposite direction; the physiological character of this determination is rather a general denutrition of the organism and of the nervous system which originates that irritability and that lack of inhibition by which men react with more difficulty against the murderous impulse.

Race, whose marked influence in biological and social manifestations is, however, denied by many eminent scientists, is nevertheless one of the concurrent factors in the determination of a crime and one which can not be overlooked. Race is not the only factor in the distribution of homicide in Europe, for side by side with this run the social economical conditions induced in their turn by this very race. In this distribution there are manifest three distinct ethnographical groups—the Græco-Latin, the Germanic with the Anglo-Saxon, and the Slav—which stand for the three large zones of homicide. In the first place for the greater frequency of homicide stand the Latin peoples—Italy, Spain, Roumania, Portugal, France, and Belgium; in the medium zone the Slav people of Russia and Austria; for the minor frequency of this crime, the peoples of Germanic origin of Germany, Holland, and England. The sad supremacy pertains not to Italy but to Spain.

With this extended survey of the organic constitution of homicidal delinquents Ferri terminates the first section of his book. The second part is devoted to the study of the psychic constitution of the murderers. He first wisely clears the ground with regard to the interpretation of psychic data and the relations be-

tween ideas and sentiments in the genesis of homicide. In this place Ferri recapitulates his famous classification of homicides into madmen born; homicides habitual, by occasion, and by passion; and finds that among these types the most characteristic and marked are the homicides born and the insane homicides, with whom alone he is occupied in this volume.*

He then exposes with a large array of facts the most marked psychological characteristics of the born homicide which constitute his psychic condition before committing his crime. These characteristics are moral insensibility; insensibility toward the victim, toward the sufferings of others, a cold ferocity in the execution of crime, which is sometimes pushed to cannibalism; an apathetic impassibility after committing the crime and even in sight of the corpse of the victim; quiet sleep after the committal of the deed. These characteristics—indifference at sight of the sufferings and death of others—are extended to the personality of the murderer himself. Such persons are noted for their moral and physical insensibility with regard to themselves, which is sometimes pushed to the point of analgesia, to impassibility to their own punishment, to indifference to death, and which also manifests itself in the frequency of suicides among delinquents. They are also cruel and insensible toward their own accomplices, whom they will betray and even kill. This ferocity, this indifference, this insensibility, of born homicides, serve as a psychological explanation of other characteristics which are conjoined to these and which help to support these views. Indifference is chronic, manifesting itself also in a preoccupation with most trifling things quite outside of the crime committed or of a diverse character, and which certainly can not by any means be attributed to a supposed corruption during confinement. They feel no repugnance to the idea or to the act of homicide before the crime. They have no moral sense, they use expressions which pertain to honest work or expressions which ridicule their crime, which they regard as a simple transgression. They do not hesitate to boast beforehand of the crime they intend to commit, as though it would do them credit; and even admit that they are disposed to commit many more; they have not, in short, any remorse concerning their offense. To this absence of remorse, of which Ferri traces the differential characteristics, must be added the obstinate denial, the disinclination to repair the injury done or to repent, the indifference to escape punishment, the easy adaptation to prison life,

* The invention of this gradation and variety of types among criminals, certainly the most fecund and fundamental, so cleverly carried into the camp of criminal anthropology, has already been put forward by Ferri before the publication of this his latest work, and he has every right to be proud of it.

the indifference to the number of their condemnations, and, in more direct mode, satisfaction in the crime consummated or remorse at not having achieved their aim; and, finally, in many cases the explicit confession that they feel no remorse or repentance. However, the lack of repugnance to crime and of remorse can not be said to be universal and to manifest itself in every direction of criminal activity, because, excepting in those criminals who have never had either the one or the other sentiment for any species of offense, there is often verified a kind of moral Daltonism which, though lacking in criminals who, having a very obtuse moral sense of certain crimes, on the other hand have a most delicate perception. One among many salient examples is that of a thief who has a horror of homicide, and of the homicide to whom the thought of theft is repellent. This moral Daltonism extends also to the impelling causes, and to the execution of the crime, that is committed for one reason and rejected for another. It extends itself to the very instruments used to commit the homicide. It may also arise from caste prejudices, as, for example, in the man who killed his brother because they were both in love with their housemaid, and who cried out in the court, "You had every right to kill me, but none to dishonor me!"

It is thus in cold blood, so to speak, that Ferri studies the psychological constitution of born homicides and the manifestation of their moral sense. He also examines their sentiments. Religious sentiment is extraneous to the genesis of crime, and hence moral and immoral men are found indifferently among atheists and believers, though the number of atheists is rare among homicides, who, as a rule, have the religious sentiment highly developed, a proof of which is found, among other things, in being tattooed with religious symbols, their superstitious piety, and lastly their true and real religious cultus, even to seeking a comfort in crime and to finding a convenient faith in pardon. As a general rule, indeed, nearly all delinquents are deeply pious. The egotistic sentiment of homicide may be resolved into the forms of *amour propre* and the sense of enjoyment, including under the latter heading pride, vanity, love of display, vendetta, covetousness, and prodigality. Homicidal thieves have also other characteristics of the true homicide, such as a reckless squandering of money acquired by murder, a passion for play, for women, and for alcohol. The ego-altruistic sentiments or those purely altruistic, such as love, family affection, etc., are not lacking in homicides when they are not in conflict with the egotistic. Murderers are even not incapable of noble actions, but their immoral temperament renders these unstable and contradictory, and thus it may occur that the same altruistic sentiment finds expression in their very crime.

And this brings us to the last portion of this study concerning the psychic constitution of murderers—that is to say, to the intellectual element. We already know the cerebral inferiority of delinquents as compared with healthy subjects. This inferiority in the class of born homicides can not be better characterized than as a weak and incomplete association of ideas. The intellectual characteristic of mental weakness in delinquents does not exclude in some of them a certain degree of intelligence in other branches of mental activity—so much so that, according to Lombroso, there are found murderers who have talent, not to say genius. These, like all born homicides, have in common the lack of a moral sentiment; as regards intelligence, they may be classed under these two headings: The sanguinary homicide, *la bête humaine*, who kills more often for vendetta or for covetousness, and the calculating homicide, who kills for covetousness and for ambition, and is often endowed with brilliant intellectual qualities. Generally speaking, however, in all criminals, as a result of their defective association of repellent ideas, there is very marked improvidence. This improvidence is shown in many criminals by the carelessness with which they themselves reveal their misdeeds, the imprudent manifestations they are the first to give during and after the consummation of the crime, the careless manner in which they leave traces of it, the way in which they return to the site of their deed, as well as in not foreseeing the punishment. In others, instead, the art they adopt to render difficult the discovery of their deeds is very marked, and the percentage of the authors of crimes who have remained undiscovered is remarkable—twenty-five per cent in Italy on crimes that have been denounced, without counting the contingent of those where even the crimes have not been discovered.

As a conclusion of this positive examination of the born homicide, Ferri thus defines the fundamental psychological characters of these persons: "Abnormal impulsiveness of action for lack of or owing to weak power of resistance to criminal desires." In general, normal man, although subject to temptations and to momentary criminal impulses, fights against them. A case in point is that of the celebrated alienist doctor Morel, who, feeling himself suddenly impelled to the idea of throwing a workman who happened to stand near him into the river, fled from the spot. The born homicide can not thus defend himself. These facts, in which is delineated the embryo of that pathological homicidal obsession which our author now goes on to examine, can be explained by congenital weakness of development, the nerve centers having been arrested, and hence not apt nor educated to resist.

It may also happen that the delinquent does not complete his

crime; but this is usually due not so much to internal resistance (active inhibition) as would occur in normal man, as to an external and present force (passive inhibition), which hinders its execution, such as an unexpected incident which takes the place at times of this defect of inhibition, giving to the delinquent the resisting force which he lacks. And this brings us by a natural transition to insane homicide. The author arrives at the conclusion that there does not exist a special form of homicidal "monomania," but that all the forms of madness may be accompanied by homicidal excess. Hence the criterion that he has adopted in his symptomatology of homicidal mania. He differs from the classification that is purely clinical and descriptive, and frequently insufficient for the scientist as for the magistrate. His favorite genetic criterion of the initial idea and the action of homicide in the insane delinquent is very useful in achieving a good result from the important and very distinct comparisons between the delinquent and the criminal madman, and the delinquent and common or non-criminal madman. As a basis for this comparison it is necessary to distinguish the insane delinquent from the non-insane, a matter of deep importance not only for science but also for jurisprudence, because from this distinction arise the various degrees of imputability and the divers means of social defense to be adopted. It is further needful to distinguish in these madmen the insane conduct exclusively due to their intellectual degeneracy from that criminal one which is also due to the lack of the moral sense. In point of fact, in non-delinquent madmen the greater abnormities are to be found in the intellectual functions, while in the delinquent abnormities of the moral sense are most marked. Of course, this is a mere academic discussion, for a real and sharp natural distinction between the forms discussed can not exist, and the non-insane delinquent and the insane are fundamentally equal when it comes to be a question of criminal manifestations.

Let us now consider the psycho-pathological symptoms of homicide. Ferri, with his rich array of facts, of opportune elucidations and examples, undertakes this examination, dividing this last section of his book into two groups which deal with the moment of the homicidal act and the attitude of the insane murderer before, during, and after its execution and during his trial; and finally, as a last chapter, he adds the conclusions to be drawn from the antecedents of the criminal's life and the recidivity of the insane homicide.

The deliberation in this unhappy person is due either to the slow invasion of the homicidal idea (homicidal obsession) or to momentary impulse. Hence two distinct generic types of psychopathological characteristics. The first type, in which the decision

to commit the crime springs from a slow and reflective process which increases from the weak or static (obsession) state until it becomes an irresistible impulse and takes a violent and dynamic form, finding vent in the criminal act, is very frequent under the influence of the delusion of persecution, in chronic alcoholics, in hysterical subjects, etc., and is also seen in other non-violent forms of mental alienation. Sometimes the madman has a perfect cognizance of his own madness, so that he will often warn others as to the crime he intends to commit and knows the punishment due to it, and yet nevertheless this will not deter him unless fortuitous external causes intervene. In fact, it often happens that madmen affected by homicidal obsession, incapable of restraining themselves, afraid of themselves, in order not to yield to the homicidal impulse, take the precaution of wounding or mutilating themselves, in order thus to divert their ungovernable impulse, and render it impossible to execute their purpose. A case in point is that of a man who, unable to dominate the violent force impelling him to murder his wife and children, consigned himself to the police and had himself shut up in an asylum.

The second type, in which the determination to homicide proceeds from a spontaneous impulse (the transitory mania of the old school of psychiatry), from a species of impulsive vertigo, without a real impulse or motive, is found generally in epileptic subjects. This tyrannous impulse toward crime is also due very frequently to hallucination and illusion, often ignored by those who have to do with madmen. Homicide from hallucination presents three subtypes: first, that in which the madman acts under the terror of a fearful hallucination (epileptics, alcoholics, etc.); secondly, in consequence of delirium from delirious homicidal premises (persecution mania); thirdly, in obedience to the imperious commands of an inward voice. Nevertheless, this does not exclude the criminal motive (vendetta, jealousy, etc.) which sometimes determines the insane to commit homicide (especially the epileptics), motives which they readily, however, confess.

To complete the psycho-pathological characteristics as to the deliberate moment of homicide in the insane, Ferri treats of homicide as an end in itself or as a means toward a legitimate end, observing that if in mad homicides murder is an end in itself (killing to kill, impulse without motive) or as a means to an end, more often social and juridic (defense from imaginary perils, withdrawal of their victim from misery, etc.), in common madmen it is always a means to reach an antisocial end. This remark is all the more important because, besides refuting the ancient affirmation which is still repeated, that delinquents have always a motive for their deed, while madmen have none, it also refutes the other no less erroneous affirmation of Esquirol

that "in delinquents murder is a means, in madmen it is an end," adopted until now by most scientists, and only lately dismissed as inadequate by the most eminent anthropologists and criminalists in consequence of Ferri's criticisms published in 1886.

In the present book the author adds two other characteristic motive factors found in mad delinquents—that is to say, homicide for purpose of suicide (for example, a man kills another in order to expiate his crime on the scaffold); and sacrificial homicide induced by the desire to kill, to sacrifice a victim for his own good or for the good of both murderer and victim. This, according to Ferri, is the attitude of the insane homicide before, during, and after his criminal excitement. First, and less common, there is the premeditation which approximates the insane homicide to the homicide born. The concomitants of this type may be the killing of his victim openly in the face of witnesses, the lack of accomplices, the latter an important feature and one that the mad homicide has almost always in common with the murderer by passionate impulse. It is not, however, unknown that madmen associate to commit crimes, from the sociability that is a characteristic of the epileptic, and forms indeed yet another proof of the fundamental identity of epilepsy and congenital delinquency with so-called moral insanity, so wonderfully demonstrated by Lombroso.

While committing the crime the manner of the mad homicide is generally agitated. He is also of a violent ferocity, which differs from that of the born homicide, which may lead him to the point of cannibalism, just as it does the latter. Another symptom, which is, however, exclusively seen in the insane (imbeciles, idiots, epileptics), is that of the monstrous sexual passion that finds its vent on the corpse of their victim (necro-philomania), to which must be added the murder of persons beloved or of persons unknown, as well as indiscriminate massacre.

The symptoms and the attitude of the mad homicide after his crime are in part common to those of the born homicide, although the psychological genesis of these symptoms is different. These are: calmness after committing the act, which often continues when arrested and during the trial, impassibility at sight of the corpse, etc. A true characteristic symptom distinguishing the mad homicide from the born homicide is great prostration and abnormal sleep into which he often falls after his murderous assault, very different from the calmness and the placid sleep of the born homicide. Notable, too, is the impulse toward suicide that seizes him immediately after the consummation of the deed, an instantaneous reaction of his moral sense, the feeling of relief, as though a heavy weight were removed, the moral Daltonism

and the moral valuation of the crime which may rise to the point of true remorse.

The characteristics of the attitude of the mad homicides during their trials are the frequent energetic protests that they are not mad, the dissimulation of their insanity or even the simulation of another form of madness different from that from which they suffer, the nonresistance when arrested, the instinctive attempt at flight, and the *alibi* they prepare for themselves in cases of premeditation; their frequently detailed confession, often made in phrases such as "It was not I. It was my head. I was blinded by my illness. I felt a blow on my head," and so forth. Or when, like other delinquents, they are not anxious to invent excuses for themselves, they either do not excuse themselves at all, or even accuse themselves of imaginary crimes, as though they wished to make themselves out worse than they are.

Ferri finally proceeds to analyze very carefully the groups of symptoms regarding the life of the criminal before and after the committal of his crime as well as his hereditary antecedents. The previous conduct of the born homicide is often very regular; and then suddenly, a little before the murder, a change of life and character will take place. Another characteristic sometimes is the perpetration of other crimes after the first homicide.

Following this last research Ferri gives us in conclusion the most important deductions which result from this portion of his great work, as to the psychical constitution of the born homicide and the mad homicide. He sums them up into twelve axioms, which should prove of invaluable use to the judicial authorities. These it is not easy to condense, and for their precise formula we must refer our readers to Ferri's book.

Crime is always a decided condition. This is the final and lucid outcome of his learned work, a conclusion at which Virgil and Lombroso respectively arrived, and a conclusion that honors these thinkers. In his future volume he promises to treat of the two other typical figures of homicides from passionate impetus and homicides from occasion, to which we look forward. One important point Ferri touches but slightly, and that is, Is crime nowadays the exception or is it not rather the rule? It must unfortunately be concluded that it is the rule in the actual epoch Europe is traversing; this does not mean, however, that crime is a normal phenomenon, but only helps to confirm the innate relations that exist between economic conditions and criminal facts, or rather, in Ferri's own words, "that the present social crisis has reached such a point as to render even criminal symptoms acute and profound, which does not exclude that in a more advanced phase of social order, such as scientific socialists look forward to, crime, like every other symptom of social pathology, will be re-

duced to the smallest proportions, such as occurs to common illnesses on the cessation of a more or less prolonged epidemic."

This book Ferri has dedicated to his little three-year-old son Dante, expressing the hope, as he says in his dedication, that when he is old enough to understand it, Italy may show fewer signs of moral pathology. It is certainly a remarkable work, and reflects great credit on its writer by its minute and impartial research.

SKETCH OF ROBERT EMPIE ROGERS.

FOR the facts in the life of ROBERT EMPIE ROGERS, as well as of the other members of this family famous in science, the memorial paper of the late Dr. W. S. W. Ruschenberger is almost our only authority. Robert Empie Rogers was the youngest of the four brothers, sons of Patrick Kerr Rogers and Hannah Blythe, whose researches, several and joint, have conferred so much honor on the name. He was born in Baltimore, Md., March 29, 1813, and died in Philadelphia, September 6, 1884. His father having been called to be Professor of Natural Philosophy and Mathematics in William and Mary College, removed to Williamsburg, Va., in 1819. There his mother died in the next year, when Robert was seven years old, and the boys, Dr. Ruschenberger says, "became almost foster children in the families of the professors." Robert seems to have received special care at the hands of the Rev. Adam P. Empie, D. D., and his wife, and in recognition of that care assumed the name of Empie. He was taught by his father, and after his death by his brothers James and William. The profession intended for him was that of engineer, and he began the exercise of it as an assistant in the survey of the Boston and Providence Railroad. Nothing is known about the engagement or the work done by young Rogers, except that the results of it were not satisfactory. In a letter written to his brother William in 1833, Robert expresses doubt of his prospect of success if he should try engineering again, and confesses that his favorite desire had always been to become an instructor. Civil engineering was given up, and Robert, having determined to study medicine, became a pupil of Dr. Robert Hare, Professor of Chemistry, "and worked zealously in his laboratory till the close of his undergraduate course." He was graduated from the Medical Department of the University of Pennsylvania in March, 1836, offering as his thesis a paper on "Experiments on the Blood, together with some New Facts in regard to Animal and Vegetable Structures, illustrative of many of the most Important Features of Organic Life." This thesis was published, with illustrations, in

the American Journal of the Medical Sciences. He, however, preferred chemistry to medicine, and served from 1876 as chemist of the first Geological Survey of Pennsylvania, under his brother Henry, who was chief of the survey. In this position he was associated with James Curtis Booth and John F. Frazer as the other assistants.

In the fall of 1841 he was invited to the University of Virginia to take the place in teaching the chemistry classes of Prof. John P. Emmet, who was ill. Prof. Emmet not recovering from his illness, Mr. Rogers was in March, 1842, elected in his place Professor of General and Applied Chemistry and Materia Medica, a position which he held with credit till 1852. In August of the latter year he was elected Professor of Chemistry, in the place of his brother, James B. Rogers, deceased, in the University of Pennsylvania. In 1856 he became Dean of the Medical Faculty of that institution. In July, 1862, during the civil war, he was appointed acting assistant surgeon in the Army of the United States, and assigned to duty in the Military Hospital at West Philadelphia, where he served not quite one year. At his suggestion a steam mangle was set up under his supervision in the neighborhood of the hospital. On the day it was completed he was showing a woman how to feed it safely, when his right hand was caught in the machinery and crushed. He was able with his other hand to throw the machine out of gear and stop it, but while a workman was lifting the cylinder, weighing eight hundred pounds, from off the disabled hand, the great piece slipped from the crowbar and fell upon it, aggravating the injury it had received. He was anxious lest his wife should be seriously shocked by too quickly realizing the severity of the mutilation he had suffered, and, to prevent this as far as possible, he left the carriage in which he was conveyed a short distance from his house and walked home. The hand was amputated by Prof. Smith, of the university, and its place was supplied for a time by an artificial hand. "Almost ambidextrous prior to the accident," says Dr. Ruschenberger, "he speedily learned to write with his left hand and to use the right arm, beneath the shoulder, in prehension with notable skill in his experiments while lecturing."

About this time the United States was swept by the "oil fever," and visions of wealth to be suddenly acquired by the possession of a well turned many an otherwise well-balanced head. Prof. Rogers did not escape the epidemic; and the fact that a man so well informed in scientific matters as he was associated in the enterprise contributed no little to the success of the scheme for organizing the Humboldt Oil Company in February, 1864, to which a capital of a quarter of a million dollars was contributed. Organization was all the success the company had. Land was

bought, wells were dug, and the work was carried on for some time without profit; and finally, in 1873, the whole concern was sold out, a nearly total loss to the shareholders. Prof. Rogers was the largest holder, having one fifth of the shares, and lost more than any of the others.

In 1872 Prof. Rogers was appointed, with Dr. H. R. Linderman, by the Secretary of the Treasury, a committee to make examinations in the mint at Philadelphia for the purpose of ascertaining the extent and sources of a waste of silver that was alleged to be taking place there "in excess of the amount tolerated by law." The processes of assaying and refining the bullion and converting it into coin were carefully tested by numerous experiments at the mint and at the Assay Office in New York. About two months were spent in the examination. The result of it was presented July 25, 1873, in a well-considered and elaborate Report on the Wastage of Silver Bullion at the Melter and Refiner's Department of the Mint. This investigation, valuable in itself, was also valuable in its consequences, because it suggested modifications in the method of refining the precious metals which were afterward adopted. The Director of the Mint said in his annual report that the results obtained were conclusive of several points, and would be valuable in future minting operations. Prof. Rogers next made an examination of the working of the mint at San Francisco, concerning which he reported to the Director of the Mint. In 1874 he experimented at the Assay Office in New York concerning means of ridding the establishment of inconveniences suffered from acid vapors. "Prior to that time nitrous-acid fumes, arising from the nitric acid used in refining silver, were allowed to escape through the chimney into the open air, seriously annoying neighbors. To correct the evil, Dr. Rogers had constructed in the attic of the building a furnace for burning coke, into which the fumes were conveyed and burned." Instead of extinguishing, these fumes promoted the combustion of the fuel. He afterward conferred with the Treasury authorities in Washington concerning plans which he had proposed for the equipment of a refinery in the mint at San Francisco. The plans, which included a sulphuric-acid process recommended by him, and the erection of additional buildings, were carried out under his supervision, and the completed work was put in charge of the superintendent in August, 1875. "At the suggestion of Dr. Rogers during the progress of the work, an artesian well was sunk within the hollow square of the mint, which supplies one hundred thousand gallons of water daily for all the uses of the establishment." The succeeding report of the Director of the Mint mentions the advantage to the public interests which attended the operation of the refinery. In connection with this work in the mint Prof.

Rogers also made a careful investigation and estimation of the probable total production of the Consolidated Virginia and California Mine in Nevada. He was further, from 1874 to 1879, or for about six years, a member every year of the Annual Assay Commission. He was for twelve years one of the chemists to make an analysis and daily photometric test of the illuminating gas supplied to Philadelphia.

In 1877 Prof. Rogers was elected Professor of Medical Chemistry and Toxicology in Jefferson Medical College; and, to accept the offer, resigned the position which he had for a quarter of a century held in the university. His entrance into this institution was the occasion of a flattering demonstration at the time of the opening of the course of 1877–'78 with an introductory lecture. "It was estimated that not less than twelve hundred physicians, students, and others were crowded into the hall. At the conclusion of the lecture a silver vase was presented to him as a token of the respect felt for him by the great class of medical students."

Prof. Rogers became a member of the Academy of Natural Sciences of Philadelphia in 1837; was interested in its proceedings through most of his life; attended its meetings at irregular intervals for many years in succession; participated in its discussions, and delivered lectures to promote its interests. Many of his verbal communications are noted in its proceedings from 1859 to 1862. He was a member of the Franklin Institute from April, 1838, except when living away from Philadelphia; became a life member in 1855; one of the Board of Managers in 1857; was one of the vice-presidents for seventeen years from 1858; was chosen president in 1875; and on retiring from that office in 1879 was returned to the Board of Managers for the rest of his life. "He was particularly active in the work of the institute, delivered courses of lectures on chemistry before its classes, assisted in the management of its public exhibitions, served on several of its standing and on many of its special committees, the most notable of which were one on tests of the efficiency of dynamo-electric machines, and another on the dangers of electric lighting." At the celebration of the semi-centennial anniversary of the foundation of the society, February 5, 1874, he delivered an address on the history of scientific discoveries and their practical applications in the half century, in which he pointed out how the work of the institute had contributed to the progress of science and the diffusion of knowledge.

He was elected a member of the American Philosophical Society in 1855 and a member of its Council in 1859. He was a frequent attendant at its meetings, served on several of its committees, and often took part in its discussions. He was less often present at the meetings of the College of Physicians, of which he

was elected a Fellow in 1857. At one of these meetings, according to Dr. Ruschenberger, he related an incident in the case of a trial for poisoning He, as an expert witness, contributed to the establishment of the fact that the subnitrate of bismuth sold in the drug stores was contaminated with arsenic, which had not previously been suspected. He became a permanent member of the American Medical Association in 1852, when he attended the meeting at Richmond as the representative of the University of Virginia. He represented the University of Pennsylvania in the meetings of 1853 and 1872, representing also at the latter meeting the medical profession of Philadelphia, and delivering the address of welcome to the delegates. He took an active part in the formation of the Society of the Alumni of the Medical Department of the University of Pennsylvania, and was its treasurer for several years. With his brothers Henry and William he took part, in 1840, in the organization of the Association of American Geologists and Naturalists, which afterward became the American Association for the Advancement of Science. The catalogue of his writings includes four papers under his own name alone in physiology, chemistry, and metallurgy; twelve papers by him and William B. Rogers in chemistry; a paper on the analysis of magnesian limestone by him and Martin H. Boyé; three papers by Dr. H. R. Linderman and him in metallurgy and electricity; a paper by James B. Rogers and him on the alleged insolubility of copper in hydrochloric acid; and seven papers by William B. Rogers and him on subjects in chemistry and meteorology. He also edited the American edition of Lehmann's Physiological Chemistry, which was published in 1855; and he was joint author, with James Blythe Rogers, of a text-book of inorganic and organic chemistry, compiled from the works of Dr. Edward Turner and Dr. William Gregory, which was published in 1846. Besides his regular occupations, Prof. Rogers was sometimes engaged as an expert in criminal trials; frequently delivered lectures, illustrated by experiments, for the benefit of institutions; and often did works of kindness and benevolence. Three instances are mentioned in which he heroically saved persons from drowning. He had a remarkable faculty, Dr. Ruschenberger says, in the use of tools of all kinds, and a respectable talent for mechanical contrivance. He was author of many inventions—notable among them the Rogers and Black steam boiler—and of several modifications and improvements of electrical apparatus. This ability was early manifested, in 1835–'36, in his original experiments on osmosis, in which he demonstrated how changes in the blood are produced by respiration.

Correspondence.

WOMAN'S CLAIMS TO THE BALLOT.

Editor Popular Science Monthly:

SIR: The "antagonism of the sexes" suggested in your criticism of my paper on Woman and the Ballot, in the June number of the Monthly, must have been read between the lines, as I have not the least feeling of that nature to betray.

I confess, however, that I have a passionate love of justice which is apt to be aroused by any attempt to forestall judgment such as was made by Mrs. Linton and Mr. Talbot in announcing the *raison d'être* for woman. Believing, as I do, that neither they nor any one else can give one iota of proof in regard to "causes of existence," whether of an *amœba* or woman, a little irony is pardonable.

No attempt whatever was made to give the important arguments in favor of woman suffrage, as these were ignored in Mr. Talbot's article, his efforts being mainly directed to the testimony of "Nature" against a feminine share of government.

One of the best reasons I can urge for the gift of the franchise to woman is its educative effect upon herself. I hold strongly to the doctrine of *personal* responsibility, and think enough evil has been accomplished by "trusteeship," however generously and conscientiously it may be exercised in particular instances.

The special laws referred to as resultants of woman's effort were: The bill granting property rights to women in the State of Vermont, October, 1847; the removal of disabilities from the women of Kansas in 1859; and the granting of property rights to the women of Connecticut in 1877. The testimony in regard to these is as follows: "From 1843 to 1853, inclusive, I edited The Windham County Democrat, published by my husband, George W. Nichols, at Brattleboro. Early in 1847 I addressed to the voters of the State a series of editorials setting forth the injustice and miserable economy of the property disabilities of married women. In October of the same year Hon. Larkin Mead, of Brattleboro, 'moved,' as he said, by Mrs. Nichols's presentation of the subject in the Democrat, introduced in the Vermont Senate a bill securing to the wife real and personal property with its use and power to defend, convey, and devise, as if sole. The bill as passed secured to the wife real estate owned by her at marriage," etc.*

In 1859 Mrs. Nichols addressed the Constitutional Convention in Kansas upon equal legal and political rights for women. Three of the four petitions presented by her were granted, the report being adopted by a solid vote of the Democrats and enough Republicans to make a majority.*

The Connecticut law of 1877 giving property rights to women was passed upon Governor Hubbard's recommendation, who, in a personal letter to Mrs. Isabella Hooker, acknowledged her influence. "Thank yourself and such as you for what there is of progress in respect to woman's rights among us."†

If these women did not supply the motive power that stimulated the sluggish masculine "sense of equity and right," then we are wrong in ascribing causative value to any pleading. It is not a case of *post hoc, propter hoc*, merely; it has the connection of the match and the flash.

As for all generalizations concerning the mental characteristics of women, I think we have as yet no adequate data, and therefore that all books founded on such premises are entirely valueless from a scientific point of view.

ALICE B. TWEEDY.

NEW YORK, *August* 25, 1896.

* Reminiscences of Clarinda I. Howard Nichols, History of Woman Suffrage, vol. i, p. 175.

* History of Woman Suffrage, vol. i, pp. 192, 193.

† History of Woman Suffrage, vol. iii, p. 386.

A CORRECTION.

Editor Popular Science Monthly:

DEAR SIR: On page 569 of the August number of the Monthly E. W. Moir makes the statement that he treated certain cases "homœopathically." The cases were patients suffering with what has been called "caisson disease." The cause of this disease is the too sudden removal of supernormal atmospheric pressure, or the too rapid removal of one from a chamber of compressed air.

To relieve the paralysis thus caused we are told that the patients were again put into a heavy atmosphere. As it was the removal from a heavy atmosphere that caused the disease, certainly reintroducing a patient into a heavy atmosphere can not be called homœopathic treatment. There are many others who misuse medical terms quite as recklessly as the word "homœopathically" is in the instance mentioned above.

Respectfully, J. M. G. CARTER, M. D.

WAUKEGAN, ILL., *August* 1, 1896.

Editor's Table.

ANOTHER BISHOP ON SCIENCE TEACHING IN ELEMENTARY SCHOOLS.

WE were not a little surprised to read in Nature some time ago an article from which it appeared that Bishop Temple, of London, had, in an address delivered before the Diocesan Conference, expressed his entire opposition to the teaching of science in elementary schools. So far as these schools were concerned he would be glad, he said, "if all these scientific subjects were got rid of entirely." Now Dr. Temple, as Nature observes, is an experienced educator. He was Head Master of Rugby at the time when he wrote his celebrated paper on The Education of the World in Essays and Reviews; and he has also been an inspector of schools and principal of a training college. He may therefore be supposed to know a good deal about education; and we can only regret that we are not in possession of a fuller statement of his views than we find in the columns of our contemporary, as it is difficult to believe that he could have expressed such opinions as those quoted without qualification. Nature, replying to the bishop, proceeds to show how important technical knowledge is to the commercial prosperity of nations. This does not fully meet the case, however: technical knowledge may be, and is doubtless, of the highest importance to a nation's commercial prosperity; and yet from an educational point of view it might (conceivably) not be advisable to introduce science into elementary schools. The question is not as to teaching science, but as to when to begin to teach it and how to teach it in the earliest stages.

If Bishop Temple, who has always been regarded as a very enlightened man, means no more than that science should not be so taught to young children as to tyrannize over their thoughts and cramp their imaginations, we could agree with him. If, on the other hand, he means that there is no way of introducing the teaching of science with advantage into the education of the young, we can only consider him seriously mistaken, and regret that he should have given the weight of his authority to a very hurtful idea. Many of our readers are doubtless aware that some eminent scientific authorities have been profoundly dissatisfied with the methods and results of science teaching in the elementary schools both of this country and of England. In spite of their predilection for scientific studies they have been forced to acknowledge that, somehow or other, science as actually taught seemed in a great many cases to possess little or no educative value. The late Prof. Huxley was very strong on this point, maintaining that the fault lay in the excessive use made of text-books and the overloading of the mind with facts which it could not properly assimilate. Bishop Temple may have witnessed a similar phenomenon; but, if so, the inference to draw is not that there is no place for science in elementary education, but that its true place has not always been understood, or that those who have assumed to teach it have not possessed the skill and insight necessary to bring it into vital relation with the minds under their charge.

As we take it, the business of science in early education is not to go

rudely counter to all the natural ideas of a child in regard to the universe, nor to impose upon him at once the somewhat oppressive conception of unvarying law, but to cause the idea of law to steal gradually into the mind, and to reveal and assert itself more and more through the successive observations which a judicious teacher will lead the child to make. Childhood, it should be needless to remark, is a period of great outward activity—a period when impressions from the world around are crowding in on the mind; it is not to any great extent a period of reflection; and any studies, therefore, which make a premature or excessive demand on the reflecting powers can not fail to do harm. The youngest child will generalize to some extent—that is to say, will do it fitfully and in regard to familiar matters; but wide generalizations in regard to unfamiliar matters lie outside of its natural sphere; and, if forced on its attention, will not only fail to interest, but will, in direct proportion to the insistence of the teacher, depress the whole play of the mental faculties and injuriously affect the development of the physical system. This is a point where many teachers go astray. Generalizations are so interesting to the adult mind, they seem to help it forward so powerfully, and to be as it were so self-luminous, that a teacher requires to possess more than the usual amount of comprehension of and sympathy with the child mind in order to recognize that they are, in the main, unsuited to the latter, and therefore only to be applied sparingly in its education. This, we conceive, explains why "clever" people, so called, often make but inferior teachers of the young. In spite of all the psychology and pedagogics they may have absorbed—perhaps occluded—they can not sufficiently and permanently, day in and day out, distinguish between the mature and the immature intellect.

Science, like everything else, to be taught successfully needs to be taught with sympathy. There should be sympathy with the subject as well as sympathy with the pupil. The reason why, in the hands of certain teachers, language and literature prove so stimulating as studies, is that the teachers feel them to be related to the higher operations and finer perceptions of the mind, and succeed in conveying this idea to those whom they instruct. The teacher of science should not be content to occupy any lower ground. The laws and facts which he expounds have their own correlation with the past history and future destinies of mankind, and with the whole compass of human thought. In dealing with the young we should endeavor to humanize science as much as possible, and to present it as having its origin in the everyday impressions of sense, and as being in its essence merely an improved and beneficent interpretation of the world in which we live.

Unless the Bishop of London is a far more reactionary person than we take him to be, what he would banish from elementary schools is just what we would ourselves banish, had we the power, namely, that formal, didactic, authoritative instruction in the facts and theories of science which is more adapted to wither than to nourish the youthful mind, not such teaching as takes the form of a gradual and sympathetic introduction to the true order of Nature. Science is just as good for the young as for the old, on the one condition that those who teach it are themselves scientific enough to understand the minds they are dealing with. And the advantage of begin-

ning betimes is that the mind early accustomed to view the universe as an infinite field of knowledge, and science simply as a method tested and proved by experience for acquiring knowledge, is placed once for all in the right relation and attitude to all questions demanding the exercise of thought. Many men of eminence in letters have expressed regret that they did not enjoy this advantage in early life; and on every hand we see proofs that the lack which they have deplored is precisely the lack under which others are laboring, without, however, a saving consciousness of their deficiency. We want more science, not less, in education, but the science must itself be scientific.

THE FOURTH BUFFALO MEETING OF THE AMERICAN ASSOCIATION.

THE meeting of the American Association in Buffalo—its fourth meeting in that city—was eminently satisfactory from a scientific point of view, and was marked by many features of interest. About four hundred members were present. Among them were two of the six founders of the association still living—Dr. James Hall, and Prof. Charles West, of Brooklyn—whose presence was fittingly mentioned by President Morley in opening the meeting. Later in the sessions a kind of jubilee meeting was held in the Geological Section in commemoration of the sixtieth anniversary of Prof. Hall's work in connection with the New York Geological Survey, when addresses were made by Prof. Joseph Le Conte, W J McGee, and others, in which special features of the survey were presented. The address of welcome by the mayor of the city was supplemented by a greeting from Dr. Roswell Park, of the Buffalo Academy of Natural Sciences, on behalf of the scientific life of the place. Buffalo—a commercial city—has no great scientific institutions, but several of modest pretensions, including its university of five professional schools, which has just celebrated its semi-centennial; a second medical school; several libraries; the academy, which boasts of its special collection relating to the American bison; and a number of smaller affiliated clubs, each devoted to some particular form of the study of Nature.

President E. D. Cope, replying to these addresses, spoke of the insignificance of our knowledge as compared with what we do not know, of the value of original research, the nature of scientific investigation, and the objects of the association. The address of retiring President Morley was on the subject of A Completed Chapter in the History of the Atomic Theory. The addresses of the sectional vice-presidents were mostly technical discussions of special topics in their several fields, but some, which we shall mention in another place, offered points of considerable general interest. A similar remark may be applied to the papers in the sections, which offered great variety in character. The proceedings of the Economic Section were marked by the discussion of monetary questions in papers by Mr. William H. Hale and Edward Atkinson; Mr. Stillman Kneeland's paper on Citizenship, its Privileges and Duties; and papers bearing on the "woman question." Studies of Indian life were presented in the Anthropological Section, and an air of realism was imparted to the matter by the opening of an Indian burial chest, found in Michigan, and the exhibition of other specimens. The Geological Section paid much attention to caves. The results of cave exploration in the United States and their bearing on the antiquity of man

were presented in an illustrated lecture by Prof. Cope and Mr. H. C. Mercer; and the making of the Mammoth Cave was explained, and a colossal cave discovered a year ago in Kentucky was described by Prof. Hovey. The last gentleman urged the formation of an American cave club. The section resolved to place a tablet on the spot where the Association of American Geologists was founded. In the Section of Mechanical Science Mr. W. S. Aldrich advocated a national endowment for engineering research, and the subject of irrigation for the eastern United States was brought to attention. The practical side of chemistry was presented in such subjects as The Chemical Problems of the Pottery Industry, Sugar-making at the Present Day, and The Use of Coal-Tar Products in Food.

In choosing Prof. Wolcott Gibbs as the president of its next meeting, the association has honored itself in honoring a veteran chemist who was famous when the majority of its present most active members were still schoolboys.

Scientific Literature.

SPECIAL BOOKS.

We have here a popular view of one division of the fruitful field that is being worked by the physiological psychologists of the present generation in Italy.* The author lays a broad foundation for his treatment of his subject by describing the general functions of each part of the brain and those of the spinal cord. He then takes up the circulation of the blood in the brain during emotion, on which he has made extended researches. He has had opportunities to take tracings from the pulsations of the brain in patients whose skulls had been fractured, and shows that any sound or sight that stimulates mental action increases the quantity of blood sent to the brain. He has tested the same thing also with a balance devised by him which has a beam large enough for a person to lie at length upon. Any mental excitement of the subject on the balance inducing a rush of blood to the brain would cause the head end of the delicately poised beam to sink. When the normal condition of the subject was restored the balance would regain its equilibrium. Dr. Mosso has also taken many tracings from the respiration, the beating of the heart, and the circulation of blood in the hands, each class of records showing the perturbations produced by excitement. The variation in the quantity of blood sent to the hands and other outlying parts of the body underlies the phenomenon of pallor, which with oppression of the chest and quickened beating of the heart are among symptoms of fear. Trembling is another one of these symptoms which Dr. Mosso examines. Taking up facial expression, he describes the nervous and muscular actions by which expression is produced, and follows this with a chapter on the physiognomy of pain, in which he gives a series of photographs of a hospital patient undergoing a

* Fear. By Angelo Mosso. Pp. 278, 12mo. London, New York, and Bombay: Longmans, Green & Co. Price, $1,75.

painful manipulation of the arm. He also considers the expression of pain in the faces of certain classic pieces of statuary. Pain is not fear, and this interesting chapter seems to have been introduced as a substitute for material that it was not practicable to obtain. Opportunities for observing fear in children, both in their waking and sleeping hours, are not so rare as in the case of adults. Our author discusses both hereditary or instinctive and induced fears of little folk and gives some suggestions as to education for courage. Other aspects of his subjects treated in the closing chapters are the influence of fear on the skin and excretions, the paralyzing influence of terror on man and animals, and the maladies and even cases of death which great fright has produced. The treatment is popular throughout, and some of the author's descriptions—for instance, those of stage fright and delirium tremens—rise to the picturesque. It contains many things that a reader would want to refer to after a first reading, but its translators do not seem to think so, for they have left it without an index.

Mr. *Conant* has added to the literature of the banking business a notably convenient and instructive book.* His record begins with banking in Italy, in which country the bank that is considered to have been the oldest, that of Venice, was founded. This is followed by accounts of banking operations in the other countries of Europe. Coming to America, he gives a chapter each to the Bank of the United States, the State banking systems, and the national banking system now in operation. The banks of Canada, Latin America, Africa, and the East also receive attention. While the author has not departed from his historical plan so far as to write a treatise on banking, yet he does not refrain from characterizing the good and the bad features of the systems that he describes. He rates the Scotch system of banks of issue as coming "nearer to the ideal of successful free banking than that of any other country," and shows that the Canadian banks were founded on Scotch models, and the first one of them largely by Scotchmen. He also gives in his first chapter a brief statement of the theory of a banking currency, and concludes the volume by setting forth the chief advantages of such a medium. Many persons who are most firmly resisting the present agitation for a change in the coinage system of the United States are convinced that a modification of our method of issuing paper money is urgently needed. Mr. Conant shares this conviction, and in the chapters just mentioned, as well as in the one especially devoted to our national banking system, he vigorously affirms the superior elasticity of bank currency over issues of Treasury notes, and condemns many of the existing restrictions on the circulation of banks as unduly burdensome.

Another historical division of the volume relates to crises—the earlier and later ones of the present century, including that of 1893—with a discussion of the causes of these catastrophes. The tendency of the work is to reveal the operation of natural laws in monetary affairs, and to show that legislation that conflicts with these laws always works mischief.

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* A History of Modern Banks of Issue, with an Account of the Economic Crises of the Present Century. By Charles A. Conant. Pp. 595, 8vo. New York and London: G. P. Putnam's Sons. Price, $3.

GENERAL NOTICES.

In her recent volume, the fourth of the Memoirs of the American Folklore Society, Mrs. *Bergen** has brought together and classified fourteen hundred and seventy five different superstitions, thus giving us the most complete collection in English. When it is known that this arduous task was accomplished during years of invalidism, and is, moreover, but the first installment of the matter in hand, we marvel at the industry of the author. The items are arranged in nineteen chapters, covering the range of current belief under the headings Babyhood, Childhood, Physical Characteristics, Projects, Halloween and other Festivals, Love and Marriage, Wishes, Dreams, Luck, Money, Visitors, Cures, Warts, Weather, Moon, Sun, Death Omens, Mortuary Customs, and Miscellaneous. What memories of childhood are aroused at the forms of asseveration, such as "Honor bright," "Hope I'll die," etc., used to bolster up some unsteady tale, or the terrible imprecation against disloyalty:

> Tell tale tit,
> Your tongue shall be slit,
> And every dog in our town
> It shall have a bit!

A deeper interest is added when we think that these childish formulæ are but parallels of the more serious rites of savages, and link the play of the one to the horrible incantations of the other. Of the augury of the daisy petals—

> He loves me, he loves me not—

nine variants are given. Other interesting kinds of "projects," or "trying fortunes," are connected with apple seeds, bed, buttons, four-leaved clovers, stars, water, etc. The fifty or more signs and charms for the causes and cures of warts will be welcome to sufferers from that affliction. To the student of comparative mythology the solar and lunar beliefs will offer many links to the Aryan stock. In fact, it is the study of relationships which gives most value to this or any work of folklore. The introduction and notes by Mr. Newell are written with the usual care and clearness of this investigator, and add an invaluable guide to the interpretation of the superstitions. Mr. Newell says: "In commending this collection to the attention of psychologists, and to the continuing industry of students of folklore, I need only express my hope that it may be sufficient to make clear how far-reaching are the studies for which folklore supplies material. The history of religion, the theory of mythologies, can not afford to overlook modern popular beliefs, in which ancient conceptions appear as still effective."

Dr. and Mrs. *Le Plongeon* spent twelve years among the ruined cities of the Mayas in Yucatan, living with the people, and are confident that they have mastered the Maya language, and learned to read the inscriptions traced in it. They have made the study of the subject the chief occupation of their lives. One who talks with Dr. Le Plongeon will hardly doubt that his assertions are sincere. From his studies of the Maya records, and his comparative studies of Eastern archæology and mythology, he draws most startling conclusions. Among those developed in this book* are the historic reality of the story of the Atlantis, and the ascription of an extreme antiquity and an extensive and potent influence to Maya civilization. When Egypt and Accad were young, or even before, he believes, the Mayas were living in Yucatan, a civilized people, with arts and architecture as we see them illustrated in the ruins at Chichen and other mysterious cities, while their colonists swarmed in Egypt and Babylonia and all the East, and left imperishable marks on the civilization and the languages of all those countries. This intercourse ceased with the catastrophe of Atlantis, which made the ocean unnavigable for thousands of years, and the story of the Mayas was forgotten. Much space is given in the book to the de-

* Current Superstitions. Edited by Fanny D. Bergen. With Notes, and an Introduction by William Wells Newell. Pp. 161, 8vo. Boston: Houghton, Mifflin & Co. Price, $2.25.

* Queen Móo and the Egyptian Sphinx. By Augustus Le Plongeon. New York: The author, and the Metaphysical Publishing Company, 503 Fifth Avenue. London: Kegan Paul, Trench & Co. Pp. 277, 4to, with two portraits and 73 photographic plates.

velopment of arguments in support of these views from verbal analogies—the most delusive of all bases for the foundation of a theory. What the author claims to derive from the study of Maya documents is entitled to more serious consideration. This is the story of the ancient Maya queen Móo, whose brother and husband, Prince Coh, was treacherously murdered by his brother Aac. Queen Móo built a magnificent mausoleum to her consort at Chichen, the ruins of which still exist and have been explored and studied by Dr. Le Plongeon, who has recovered and possesses the charred heart of the prince, and the stone spear heads with which he was killed. Queen Móo, having refused to marry her husband's murderer, was obliged to flee from her country, and sought refuge on one of the islands of the sunken Atlantis. Here the Maya record stops; but Dr. Le Plongeon infers, from his Egyptian studies, that not finding the refuge she sought, she went on to Egypt, where she was warmly welcomed by Maya colonists and became influential. Her name, the author affirms, is preserved in that of the Egyptian Queen Mau; her story, with that of her murdered husband, became the myth of Isis and Osiris; and she caused the Sphinx to be carved as a memorial to her husband. Dr. Le Plongeon finds the story of Atlantis fully recorded on a stone which is preserved in Chichen, "as intact to-day as when it came from the hands of the sculptor," and also in the manuscript Troano and the Codex Cortesianus; and he further affirms that it was embodied by a Maya living in Greece in the Greek alphabet, the names of the letters of which, as recited by students, each represent one of the lines of the poem. Dr. Le Plongeon's theories are utterly at variance with those of the recognized Americanists; but if he errs, it is not from ignorance, for if he can read ancient Maya, he knows more than all of them, and his other reading has been amazingly wide. There is, however, the possibility that he has been carried away by an unbounded enthusiasm.

In his work on *Wages and Capital*,* Prof. *Taussig* inverts the usual order of proceedings by presenting his own views first, in five chapters, and reviewing the history of the wages-fund discussion from its beginning to the present, in the chapters that follow. This he does because criticism and comment proceed inevitably from the thinker's own point of view, and the proper estimation of their value depends largely on the reader's knowing what that is. In the first five chapters (author's view) it appears that all wages are paid from the products of past labor, and that the supply of products of past labor exists mainly in the form of real capital; that the class of hired laborers derive their wages from capital in this sense, and are dependent for their share of the real income, into which capital steadily ripens, on the funds which the employing class find it advantageous to turn over to them. The inquiry is then made whether the capital from which wages come is rigid or elastic, with a conclusion against rigidity. The inquiry results in the conclusion that the old doctrine of the wages fund had a solid basis in its conception, incomplete yet in essentials just, of the payment of present labor from past product. The theory thus arrived at shows the steps by which the wages get into the laborer's hands, describes the machinery of production and distribution, and so points to the nearest and most obvious causes which affect them; but it does not tell the whole story. In the critical review forming the latter part of the book, which begins with the writers before Adam Smith and includes contemporary discussion, the vogue of Mr. George's Progress and Poverty is declared not due to any solid or consistent reasoning, or to any novelty in principle, and to have excited no great influence on trained students. The author reviews Prof. Francis A. Walker's contributions to the discussion at considerable length, and maintains that they have never touched the essentials of the matter. Finally, while the controversy over the wages fund is acknowledged to be a barren one so far as it is an effort to define the causes which finally distribute wages and settle distribution at large, the author holds that something may still be gained from it as a mode of describing the methods and sequence of production and related points.

* Wages and Capital: An Examination of the Wages-Fund Doctrine. By F. W. Taussig. New York: D. Appleton & Co. Pp. 225. Price, $1.50.

Prof. *Hadley* describes his book on *Economics** as an attempt to apply the methods of modern science to the problems of modern business. As among the important changes in economic theory that have taken place within the last thirty years, he mentions the application, by different schools of investigators, of the principle of natural selection and of the results of psychological study to account for the aspects of the subject to which they may severally apply. But these things have combined to make the economic science of the present day very different from that which formed the basis of John Stuart Mill's presentation: "Meanwhile, new problems have been developing in modern business life; most conspicuously, perhaps, in connection with large investments of capital in factories and railroads. The time which elapses between the rendering of labor and the utilization of the products of labor is now so long that the work of the speculator has far greater importance than it had a generation ago. The size of the units of capital is so large that free competition often becomes an impossibility, and theories of economics which are based upon the existence of such competition prove blind guides in dealing with modern price movements. We have to study, far more closely than we once did, the effect of combinations upon the interests of the consumers on the one hand and the laborers on the other; to examine the results of meeting organizations of capital with organizations of labor, and of controlling them by special legislation, or by direct government ownership. We have to deal with socialism, not as the theory of a few visionaries who try to destroy property rights, but as a series of practical measures, urged by a large and influential body of men who are engaged in extending the functions of government." The endeavor is made to supply the lack of any general work in the English language dealing comprehensively with these problems of modern economics. The book is written for students who are thinkers and for men who are engaged in doing the world's work, and is hardly likely to be found adapted to superficial readers. The special subjects treated are Public and Private Wealth, Economic Responsibility, Competition, Speculation, Investment of Capital, combination of Capital, Money, Credit, Profits, Wages, Machinery and Labor, Co-operation, Protective Legislation, and Government Revenue.

Mr. *Thomas S. Blair*, taking up the question embodied in the second title of his book on *Human Progress*,* and finding the present state of knowledge inadequate to furnish an answer, reasons that the complexity of the facts of human experience has been too much for the philosophers, seeks for an instance of better results elsewhere, and finds it in the case of the successful man of affairs. In this book he undertakes to present the conclusions he has reached through the application of business methods to his subject. He supposes man himself to have become the chief agency in the furtherance of the Creator's scheme for his evolution, his efficiency as such being brought through the operation of his experience of the natural laws controlling his evolution, whereby he becomes acquainted with them and learns to assist in giving them free play. According to the author's philosophy, human knowledge is limited to the form of working hypotheses as guides of action, but is capable of indefinite expansion within its limitations, and includes a large scope of knowledge of objective realities; the knowledge of the actual existence of the basis of religious sentiment is as unequivocal, direct, and conclusive as the knowledge of our own existence, and thus religion is established on a rigidly scientific foundation; and the active principle in the scheme of human progress is the impulse to satisfy wants, operating under a law of man's being, according to which the satisfaction of a want is followed by the emergence of a new want, which is normally of a higher order than the want which it succeeds. Confirmation of these conclusions is looked for in the provision which Nature has made for the satisfying of wants of various kinds and the awakening of higher ones. The statements of principles

* Economics: An Account of the Relations between Private Property and Public Welfare. By Arthur Twining Hadley. New York and London: G. P. Putnam's Sons. Pp. 490. Price, $2.50.

* Human Progress: What can Man do to Further it? By Thomas S. Blair. New York: William R. Jenkins. Pp. 573. Price, $1.50.

and the arguments are overlaid with much verbiage, and this makes the book very hard reading.

The *Dictionary of Chemical Solubilities* of Prof. *Arthur M. Comey* (Macmillan, $5) was an undertaking German in laboriousness and American in enterprise, and the finished volume is a monument of able and persevering effort. Although this work is nominally limited to the inorganic substances, exceptions have been made by including in it CO_2, CO, CS_2, the carbonates, cyanides, ferrocyanides, etc. Prof. Comey acknowledges receiving much aid from the earlier dictionary of Prof. Storer, but he found the material that has accumulated since 1860, the limit of that work, to be far greater than that previously extant. Different results given by different observers have been set down in many cases, with the authority for each, as it would have been manifestly impossible to verify all such conflicting statements experimentally. Under each title the solubility of the substance in water is first given, the date being arranged chronologically in the longer articles. Then follow the specific gravities of the aqueous solutions, and also any data obtainable regarding their boiling points. Following this is the solubility of the substance in other solvents—first the inorganic acids, then alkali and salt solutions, and finally organic substances. While many of the rarer substances are disposed of in a couple of lines, some of the more important occupy several pages: thus ammonia has five and a fourth pages, glass over three and a half, potassium nitrate nearly as much, and sulphuric acid over four. In putting the material together many puzzling problems of nomenclature and arrangement had to be solved, but Dr. Comey's own practical sense has been supplemented by wise counsel, and when the user of the volume reflects that the dictionary plan can give the maximum of convenience only by sometimes disregarding logic and relationship he will agree that these questions have been well decided.

The University of the State of New York has issued Museum Bulletin 14 on the *Geology of Moriah and Westport Townships, Essex County*. Besides describing the general geology of these townships, this pamphlet gives the latest information on the important iron-ore deposits of that region, and reviews the probable hypotheses as to their origin. It contains a geologic map of the two townships, a map of Mineville iron region, and half-tone views of the mining district and sections of the ore bodies. The bulletin is mailed by the State Library on receipt of ten cents.

The Natural Science Association of Staten Island has performed a commendable service to local geography and history by publishing the collection of *Staten Island Names*, compiled by *William T. Davis*, and the accompanying map prepared by Charles W. Leng. Names for natural features of the island and the waters surrounding it, and for ferries, roads, and villages are included in the collection. With each name is given the location of the place to which it was applied, and in many cases a quotation from some old advertisement, deed, or map is added as authority. With some a legend connected with the place is inserted. The list makes a pamphlet of fifty-seven pages, which may be had for 50 cents from Arthur Hollick, secretary of the association, at New Brighton, N. Y.

A new and enlarged edition of *Hypnotism, Mesmerism, and the New Witchcraft*, by *Ernest Hart*, M. D., has been issued recently (Appletons, $1.50). The original edition was noticed fully in our number for October, 1893. Dr. Hart's general conclusions in regard to hypnotism are that it is very rarely useful for curative purposes, and is dangerous for platform performances and private amusement. In a new chapter entitled The Eternal Gullible, Dr. Hart gives the confessions of a professional "subject" who had appeared in performances with a number of well-known "professors" in London. An appendix contains some lively controversial letters contributed to the British press by Dr. Hart, Dr. Luys, and Prof. Sidgwick.

With this may be mentioned *A Study in Hypnotism*, by *Sydney Flower*, which is a story of a hypnotizer's courtship with one of his subjects (Psychic Publishing Co., Chicago).

Hypnotism and its Relation to Witchcraft, Ghostology, and Mind-cure is the subject of a lecture by *J. H. Fisher*, which is published as a pamphlet (Seymour & Muir Printing Co., Grand Rapids). Mr. Fisher expresses him-

self in a vigorous and humorous style, and brushes away the nonsense from the popular idea of hypnotism with an unsparing hand, exposing as he goes along many of the tricks of platform "professors." He maintains that good subjects, when not confederates, are hypnotized by their own faith in the power of the operator, that the healing by saintly relics and Christian science is due to just such faith, and that ghosts and witches have had their only existence in a similarly strong belief.

Hypnotism is treated more respectfully in a little pamphlet by Prof. *G. A. Keene* (the author, Masonic Temple, Chicago, 15 cents), who gives a general exposition of the subject, and firmly maintains its value in medicine and surgery. All of these publications except the second are illustrated.

The *Examination of Weismannism*, by Dr. *G. J. Romanes* (Open Court Publishing Co., 35 cents), consists of a series of essays discussing the phases of Weismann's theory of evolution as they have appeared in that investigator's successive publications. The first chapter is a statement of Weismann's system up to the year 1886, and the second supplies additions bringing it up to 1892. Then follow examinations of Weismann's theories of heredity and evolution as they stood in 1891, and a final chapter brings the subject up to 1893. From this discussion Dr. Romanes excludes the doctrine of non-inheritance of acquired characters, and deals only with "the elaborate system of theories which Weismann has reared upon his fundamental postulate." He represents these theories as being in a continual flux and change, and he had intended to add supplementary chapters to future editions of this book in order to keep pace with further developments which he expected to appear. In his opposition to Weismann, Romanes was largely on common ground with Spencer, but there were points upon which he took issue with the latter, some of which are set forth in an appendix. Another appendix contains certain supplementary suggestions on Weismann's theory of germ-plasm.

One important way in which the fingers of primitive man assisted his wits is impressed upon our attention by Dr. *Levi L. Conant's* study of *The Number Concept* (Macmillan, $2). The number systems of nearly all existing peoples evidently arose from counting on the fingers—some using one, some both hands, and others supplementing the fingers by the toes. Dr. Conant mentions, however, a few tribes who have numeral words only for one, two, and many, and some even whose only numeral seems to be one. He shows from a large number of numeral vocabularies that number words have been suggested in very many languages by the act of telling off the fingers in counting. Examples are words meaning "the end is bent" for 1, "the notched off" or "one hand" for 5, "one on the foot" for 11, and "one man" (all the fingers and toes) for 20. While most peoples have five or ten as their number base, a few have two, going on with words meaning two-one, two-two, etc. Four is also used as a base, but Dr. Conant has found no recorded instance of a number system formed on 6, 7, 8, or 9. It has been announced recently that the Aphos, an African tribe, have the best of all systems, the duodecimal, but the report has yet to be verified. The vigesimal system, either alone or combined with the quinary, appears in many places and persists even in the French *quatre-vingts*. The author believes that he has brought together for this discussion the largest existing collection of numeral systems.

Among the publications issued by the Sound Money League of Pennsylvania is No. 13, *A Dissatisfied Farmer*, which shows that most of the depression under which agriculture in the United States now labors is due to competition, and especially to the competition of the wholesale operations carried on in the West. The little pamphlet is illustrated with excellent photo-engravings showing old and new methods of agriculture, stock-raising, and transportation. (Room 248, The Bourse, Philadelphia.)

Under the title *The Union College Practical Lectures* there have been collected in a volume thirteen lectures delivered at Union College in a course instituted by General Daniel Butterfield. The plan of the course has been evidently to get men prominent in affairs to talk about their respective specialties to the students of the college. Thus the first lecture on the list is an account of the

Military Academy at West Point by General P. S. Michie, dean of the faculty of the academy, and the late A. H. Rice, ex-Governor of Massachusetts, gave Some Inside Views of the Gubernatorial Office. Six of the addresses were on public affairs; Henry W. Cannon spoke on Banking and Currency, Montgomery Schuyler on Architecture, Andrew Carnegie on Wealth and its Uses, while pure and applied science were represented by the lecture of Albon Man on Electricity, of General William A. Hammond on Brains and Muscles, of ex-Governor Alonzo B. Cornell on The Electro-magnetic Telegraph, and of Colonel F. V. Greene on Roads. The volume contains the portrait and a short biographical sketch of each lecturer. (F. T. Neely.)

The summary and index of *Legislation by States in 1895*, issued by the New York State Library (University of the State of New York, 35 cents), contains 4,847 entries. This bulletin, which has now been published for six years, is of great service in putting State legislators in possession of the recent work done in other States, and thereby promoting progress and uniformity. A new feature this year is a separate table of constitutional amendments arranged by States, showing the result of the vote on all amendments in 1894 and 1895, and giving also those to be submitted to future vote.

Having made a thorough lexicographic study of mineral names for the new dictionary of the Philological Society, Prof. *Albert H. Chester* has recently issued the results of his labors separately as *A Dictionary of the Names of Minerals* (New York: Wiley, $3.50; London: Chapman & Hall). He has aimed to give with each name its correct spelling, its author, a reference to its first publication, its original spelling, its derivation, the reason for choosing this particular name, and a short description of the mineral to which it belongs. In a few cases he was unable to determine one or more of these points, and he sends out with the volume a circular asking aid in securing the lacking information. Nearly five thousand names are included in the dictionary, and many of the facts concerning them are now given in a vocabulary for the first time, having been gathered from little known books or from private communications. A considerable number of imaginary derivations and other errors are corrected in this work. An introduction contains an interesting history of attempts to systematize mineralogical names, accounts of the introduction of some errors, and other similar matter. A list of works cited fills nineteen pages, and an index to the authors of mineral names occupies twenty-four more.

The Annual Literary Index, edited by *W. I. Fletcher* and *R. R. Bowker* (The Publishers' Weekly, $3.50), is an annual supplement to Poole's valuable index to periodicals and, by the addition of one feature after another, has become much more than that. The volume for 1895 contains besides the Index to Periodicals an Index to General Literature, which rather ambitious title denotes an index to the contents of one hundred and thirty or forty volumes of essays, biographical sketches, etc., published in 1895. There is an Author-index covering these two lists, which is followed by a list of the American and English bibliographies that have appeared (in treatises or separately) in the course of the year, a Necrology of Writers, and an Index to Dates of Principal Events. This last is a new feature, and besides its independent historical value it is practically an index to the files of any newspaper.

The second annual volume of MM. H. Beaunis and A. Binet's *Année Psychologique* (Psychological Annual) for 1895 is much larger than the first, and forms a book of 1010 pages. The volume, which is published from the Laboratory of Physiological Psychology of the Sorbonne, contains, under the heading of Memoirs of Collaborators, papers on Abnormal and Morbid Characters, by Prof. Ribot; A Glance at Comparative Psychology, by M. Fosel; An Experiment in Reading in which Certain Categories of Words are omitted, by M. Flourney; On Intellectual Phenomena, by M. Bererdon; A Note on the Conditions favoring Hypnotism, by M. Gley; and Illusions of Weight, by M. Biérnléet. Other papers are given under the headings Works from the Laboratory and General Reviews. The second part of the volume contains analyses of publications and papers that fills fourteen chapters, each covering its separate department, with subdivisions; four *Études d'ensemble*, or General

Studies, by Charlin, Maudsley, Morselli, and Wernicke; Necrological Notices; and a bibliography embracing 1,394 titles, with an index of authors—these credited to the Psychological Review. (Published in Paris by Félix Alcan. Price, 15 francs.)

Home Study is a new illustrated monthly intended for elementary students of the various engineering and architectural branches. Vol. I, No. 3, contains several interesting and instructive articles, among which may be mentioned Stability of Vessels, Electric Currents, Chokage of Drains, Foul Air of Rooms, The Modern Theory of Heat, and Circulating Decimals. (Scranton, Pa. $1.50; 15 cents.)

The Bamboo Garden, by *A. B. Freeman-Mitford* (Macmillan, $3), is an attempt to give a descriptive list of the hardy bamboos in cultivation in England, and to focus such information in regard to them as could be obtained from Japanese as well as from European sources. The methods of propagation, and choice of position and soil, are considered in the early chapters. Chapter IV deals with the manifold uses to which the bamboo is put, and the curious customs and superstitions connected with the plant in Eastern countries. The remainder of the book consists of a classification and description of species. A few illustrations accompany the text.

Press Working of Metals, by *Oberlin Smith* (New York: Wiley; London: Chapman & Hall), is a treatise upon the principles of shaping metals in dies, and a description of these dies, both those in present use and of past stages in the art of metal-working. The body of the work is prefaced by a short historical sketch on the probable origin of the art, and the crude methods which were at first employed. The book is essentially technical and of interest to only a special class. Good illustrations are quite numerous.

PUBLICATIONS RECEIVED.

Agricultural Experiment Stations. Connecticut: Cost of Nitrogen, Phosphoric Acid, and Potash in Connecticut; Examination of Food Products sold in Connecticut.—Michigan State College: Tuberculosis and A Preliminary Bulletin on Pasteurization of Milk.—New Hampshire College: 35. The Codling Moth and the Apple Maggot; 36. Analysis of Three Common Insecticides; 37. Crimson Clover.—New York: Notes on the Recent Invasion of the Army Worm.—Ohio: Peach Yellows; Black Knot and San José Scale, and Fertilizers on Wheat.—Purdue University (Indiana): Field Experiments with Wheat.—United States Department: Climate and Crop Service for July; Fodder and Forage Plants exclusive of the Grasses.

Alabama Geological Survey. Iron-making in Alabama. Pp. 164. Bulletin No. 5: A Preliminary Report of the Resources of the Upper Gold Belt. Pp. 202.

Baker, Marcus. The Alaskan Boundary. Pp. 16.

Bell, Alexander M. English Visible Speech in Twelve Lessons. Washington: (The Author.) Pp. 30. 50 cents.

Davis, Gualterio C., Director. Anales de la Oficina metereológica Argentina. Vol. X. Climatology of Salta, Tucuman, Carcarana, and Villa Maria. Buenos Aires: Pablo E. Coni & Sons. Pp. 556.

Fischer, P. D. Betrachtungen eines in Deutschland reisenden Deutschen (Reflections of a German traveling in Germany). Berlin: Julius Springer. Pp. 247. 8 marks.

Francke, Kuno. Social Forces in German Literature. New York: Henry Holt & Co. Pp. 577.

Hay, O. P. On Some Collections of Fishes and on The Skeleton of Soxochelys Latiremis. Field Columbian Museum Publications. Zoölogical Series. Vol. I. Nos. 4 and 5.

Harvard University Publications. Memoirs of the Peabody Museum. Vol. I. No. 1. Prehistoric Ruins of Copan, Honduras.

Hill, D. J. An Honest Dollar the Basis of Prosperity. New York: The National Republican Executive Committee.

Hypnotic Magazine, The (monthly). Chicago: The Psychic Publishing Co. 25 cents, $2.50 per annum.

Kansas Academy of Science. Transactions of the Twenty-sixth and Twenty-seventh Annual Meetings. Pp. 370.

Labor, Bulletin of Department of. No. 5. July, 1896. Convict Labor. Pp. 120.

Magpie, The (monthly). 10 cents, $1 per annum.

Munroe, John. The Story of Electricity (The Library of Useful Stories). New York: D. Appleton & Co. Pp. 187. 40 cents.

New York State Reformatory (Elmira) Yearbook for 1895.

Reprints. Call, R. E.: A Revision and Synonymy of the Parvus Group of Unionidæ, etc. (Proceedings of Indiana Academy of Science for 1895).—Peterson, F., M. D.: The Stigmata of Degeneration (State Hospital Bulletin, July, 1896).—Schnabel, E. D., M. D.: Hereditary Syphilis of the Nervous System (Lehigh Valley Medical Magazine, Vol. VII, No. 7).—Sparre, Henric: Treatment by Remedial Gymnastics (Medical Current, July and August, 1895).—Ward, Lester F. The Principles of Sociology (Proceedings of American Academy of Political and Social Science).—Walker, S. T.: Clinical Examination of Deaf-Mutes (Cincinnati Lancet-Clinic, July 4, 1896).

Revista da Sociedade de Geographia do Rio de Janeiro (Review of the Geographical Society of Rio de Janeiro). Vol. XI, 1895. Rio de Janeiro: Leuzinger. Pp. 110.

Smithsonian Publications: 1083. Catalogue of a Collection of Birds of Eastern Turkestan, Central Asia, etc.—1084. Description of Three Species of Sand Fleas at Newport, R. I.—1085. Remarks on the Synonymy of some North American Scolytid Beetles.—1086. Fossil Jelly Fishes from the Middle Cambrian Terrane.—1087. Pre-

liminary Description of a New Genus and Three New Species of Crustaceans from an Artesian Well at San Marcos, Texas.—1088. Description of a New Genus and Species of Blind Tailed Batrachian from the Subterranean Waters of Texas.—1089. Description of a New Stickleback from the Coast of Maine.—1090. Description of a New Species of Ant Thrush from Nicaragua.—1091. Partial List of Birds collected at Altamira, Mexico, by F. B. Armstrong.—1092. On Some Prepared Parasitic Hymenopterous Insects from Ceylon.—1093. An Annotated List of Birds observed on Margarita Island and at Guanta and Laguayra, Venezuela.—1094. List of Coleoptera collected on the Tana River and on the Jomboul Range, East Africa.

Taber, C. A. M. The Coming Ice Age. Boston: George H. Ellis. Pp. 94.

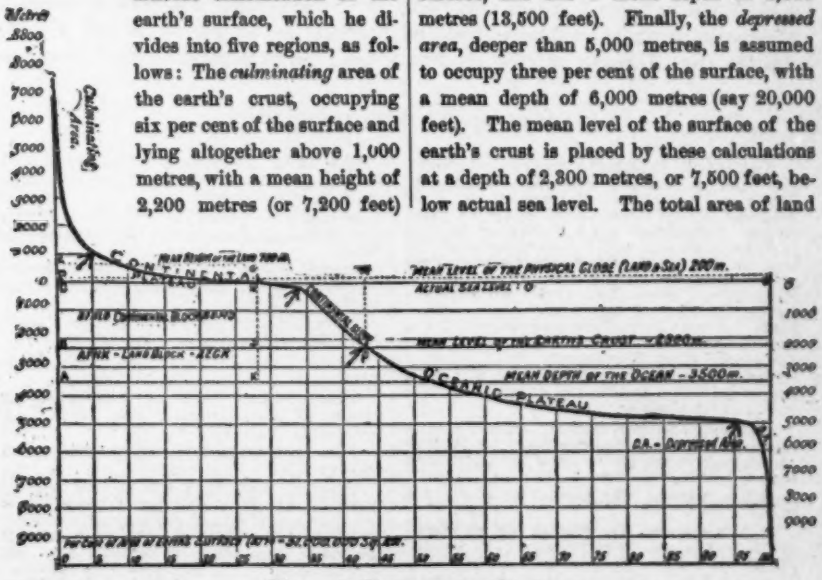
Tilden, J. H. Cursed before Birth. Denver, Col.: (Author). Pp. 314.

White, E. E. A School Algebra. New York: American Book Company. Pp. 394. $1.

Wilson, Dr. Erastus. La Enseñanza Moderna (Modern Education). Article 24. Summary of the Papers in the Annals of the Institute of Secondary Instruction of Havana. Havana: Military Printing Office. Pp. 14. Distributed.

Fragments of Science.

A New Classification of Elevation Areas.—Prof. Hermann Wagner, of Göttingen, one of the best-known geographers and statisticians of Germany, has recently published a new altitude classification of the earth's surface, which he divides into five regions, as follows: The *culminating* area of the earth's crust, occupying six per cent of the surface and lying altogether above 1,000 metres, with a mean height of 2,200 metres (or 7,200 feet) above the sea. The *continental plateau*, occupying all the surface from the 1,000 metre contour line of elevation to the 200 metre contour line of depth—i. e., to the margin of the shallow sea border or continental shelf; it comprises 26·3 per cent of the surface, and has a mean elevation of 250 metres (800 feet) above the sea. The *continental slope*, from a depth of 200 metres to 2,300 below sea level, covers nine per cent of the earth's surface, and has a mean depth of 1,300 metres (4,300 feet). The *oceanic plateau*, between the depths of 2,300 and 5,000 metres, occupies no less than 57·3 per cent of the surface, and has a mean depth of 4,100 metres (13,500 feet). Finally, the *depressed area*, deeper than 5,000 metres, is assumed to occupy three per cent of the surface, with a mean depth of 6,000 metres (say 20,000 feet). The mean level of the surface of the earth's crust is placed by these calculations at a depth of 2,300 metres, or 7,500 feet, below actual sea level. The total area of land is worked out at 28·3 per cent and that of sea at 71·7 per cent of the earth's surface; the ratio of land to water surface is thus 1 : 2·54. The accompanying chart is reproduced from Nature of June 4th.


Metres
Culminating Area
MEAN LEVEL OF THE PHYSICAL GLOBE (LAND & SEA) 200 m.
ACTUAL SEA LEVEL = 0
MEAN LEVEL OF THE SOLID CRUST = 2300 m.
MEAN DEPTH OF THE OCEAN = 3500 m.
OCEANIC PLATEAU

WAGNER'S HYPSOGRAPHIC CURVE.

Silk from Wood.—According to the London Times, there is growing up in France a considerable industry, based on the manufacture of a so-called silk from wood pulp.

The works are at Besançon, and utilize a process devised by M. de Chardonnet, which is as follows: The pulp, thoroughly cleansed and looking very much like thick gum, is put into cylinders, from which it is forced through pipes into the spinning department. Here the machinery is very similar to that of the ordinary spinning shed, except that one of these pipes passes to each machine. The pipes are supplied with small taps, fixed close together, and each tap has a glass tube about the size of a gas burner, at the extreme point of which is a minute aperture, and through this the pulp is forced. These glass tubes are called the silkworms, and some twelve thousand of them are in use in the factory at Besançon. The pulp appears as a minute globule. This a girl touches with her thumb, to which it adheres, and she draws out an almost invisible filament, which she passes through the guides and onto the bobbin. Then, one by one, she takes eight, ten, or twelve other such filaments, according to the thickness of the thread to be made, and passes them through the same guides and onto the same bobbin. The subsequent details are practically those of ordinary natural silk spinning. The chief difference in appearance between the natural and the artificial silk is in the greater luster of the latter. The new product is said to take dye much more readily than the natural silk, but not to be quite so strong. It is stated that a factory for the manufacture of this material is to be erected near Manchester, England, which will cost $150,000.

Old Madagascar War Customs.—Descriptions of curious war customs that prevailed in Madagascar are quoted by M. A. Grandidier from Mayeur, who visited that country in 1785, or more than a hundred years ago. The hostile bands usually agreed on the day and place of the battle, and at the appointed time the opposing parties marched to the designated spot. When all was ready, some of the soldiers of one host advanced, fired their guns, and ran back to the protection of their army. While these were reloading, the soldiers on the opposite side went through the same manœuvre; and this was continued till one of the hosts got so much the worse of the fight that it retired. Both armies would then go home and return to the occupations of peace, to resume their odd hostilities at some future time. The first battle that Mayeur witnessed lasted from ten o'clock in the morning till four o'clock in the afternoon, with twelve thousand soldiers in line, without victory to either side, while there were twenty-two killed and wounded. Ten days afterward, one of the chiefs having obtained re-enforcements, the fight was resumed and hotly contested till, in the very thickest of it, a cloud of locusts suddenly darkened the sky and alighted on the neighboring rice fields. Firing was stopped at once, and all the combatants went pell-mell to picking the destructive insects, of which they were very fond as food. Women, children, and old men hurried out of the villages, where they had hidden themselves, and mingled with the soldiers; and in less than a quarter of an hour the plain was covered with more than twenty thousand people, squatting on all fours and capturing the insects. It was the custom, M. Grandidier observes, to suspend hostilities in the presence of a plague, which, as the king said to Mayeur, threatens a whole people, while war generally interests only the chief who makes it.

The Year's Polar Expeditions.—Dr. Frithiof Nansen, who started from Christiania, Norway, in June, 1893, in the little vessel Fram, to reach the north pole if possible, has returned, after having attained latitude 86° 14′ north, within about two hundred and fifty miles of the pole, the highest point yet reached. (An excursion twelve miles farther on *ski* is also mentioned.) Dr. Nansen started with the expectation of meeting a current in which his vessel would be borne along with the ice to the pole and past it, basing the expectation on information which has since been found to be false. The Fram was constructed in a peculiar manner, so that when it met the heavy ice it should be lifted up and borne upon it instead of being crushed by it. In latitude 78° 50′ north, longitude 133° 37′ east, and in the latter part of September, 1893, the ship was allowed to be closed in by the ice, and was then drifted north and northwestward during the fall and winter months. A sudden increase in the depth of the water at latitude 70° to from sixteen hundred to nineteen hundred fathoms seems, according to Dr. Nansen, to upset the theories

that are based upon a shallow polar basin. The sea bottom was remarkably devoid of organic matter. Under the surface of cold ice water covering the polar basin warmer and more saline water was found, probably from the Gulf Stream. No land and no open water, except narrow creeks, were seen. A few days after Christmas, 1894, the Fram was at latitude 83° 24′, the farthest north that had been reached. Dr. Nansen here left the ship, taking Lieutenant Johansen with him, to explore the sea farther north. He reached his highest point on April 7, 1895, and, finding the prospect of a further advance discouraging, started on his return journey the next day. He reached Franz-Josef Land June 7th of this year; was embarrassed to find Payer's map all wrong; and, after sailing and paddling around for several weeks in the supposed direction of Spitzbergen, met the steamer Windward. Leaving Franz-Josef Land in this vessel, August 7th, he and his companion were brought by a short and very pleasant passage to Vardöe, Norway. The Fram, which Dr. Nansen left in charge of its master, Captain Sverdrup, returned safely to Norway only a few days after Dr. Nansen's arrival. Persons best informed in arctic research affirm that the expedition has made many and valuable discoveries.

An expedition of eminent explorers, among whom are Sir W. Martin Conway and Mr. Trevor Battye, which started out to cross Spitzbergen and explore its interior, has successfully accomplished its purpose. M. Andrée, who went to the polar regions for the purpose of attempting to reach the pole by balloon, found himself constantly baffled by opposing winds, and has returned, having been obliged to give up the attempt for this year.

Poisonous Spider Bites.—It has always been questioned whether the bites of the spiders of the temperate zone were ever fatal. Popular belief has it that they sometimes are, but spider students generally scout the notion. A few cases have recently been cited, however, on testimony which can hardly be doubted, that point to an affirmative answer. An account is given in Dr. Riley's Insect Life of a man in excellent health who died fourteen hours after having been bitten in the neck by the species *Latrodectus mactans*. He instantly felt an intense pain, and picked off from the wound a spider of the species named. Four hours afterward the spot was marked by a circle of little white pimples about as large as a silver half dollar, but the wound itself was not seen; and, while there was no swelling, the neck and left arm were rigidly hard. Violent pains ensued, reaching the intestines, but the sufferer was able to go to the village for whisky and back, after which spasms set in. Six cases of spider bites, observed by M. Corson de Savannat, were followed by serious but not mortal effect. The identity of the conditions under which the bites were received and the similarity of the observed symptoms give the cases resemblance to real laboratory experiments. All suffered great pains in the abdomen and back and tetanic contractions lasting several hours, with dyspnoic respiration and rapid, strong pulse. The patients' condition appeared desperate without its being possible to define any particular local pain. The cases were treated with injections of chlorhydrate of morphine and internal stimulants. Similar nervous troubles and contractions were marked in 1833 by M. Graells, of Barcelona, as following bites by the *Latrodectus mamignatus*. In some cases a rash is mentioned as breaking out in a few hours either in the region around the bite or over the whole body. A spider whose bite is regarded as fatal is found on the seashore of New Zealand. The symptoms following the bites of these spiders are described by the New Zealand doctors as like those consequent upon the action of narcotics, while those produced by our northern spiders are rather convulsive.

Alaska.—Mr. W. H. Dall, in his paper on Alaska as it Was and Is (1865–1895), describes the region which includes the Aleutian chain and other islands west of Kadiak as presenting a striking contrast "to the densely wooded mountains and shining glaciers of the Sitkan region to the east and the rolling tundra, cut by myriad rivers, in the north. Approached by sea, the Aleutian Islands seem gloomy and inhospitable. Omnipresent fog wreaths hang about steep cliffs of dark volcanic rock. An angry surf vibrates to and fro amid outstanding pinnacles, where innumerable sea birds wheel

and cry. The angular hills and long slopes of talus are not softened by any arborescent veil. The infrequent villages nestle behind sheltering bluffs, and are rarely visible from without the harbors. In winter all the heights are wrapped in snow, and storms of terrific violence drive commerce from the sea about them. Once pass within the harbors during summer and the repellent features of the landscape seem to vanish. The mountain sides are clothed with soft yet vivid green, and brilliant with many flowers. The perfume of the spring blossoms is often heavy on the air. The lowlands are shoulder high with herbage, and the total absence of trees gives to the landscape an individuality all its own. No more fascinating prospect do I know than a view of the harbor of Unalashka from a hill top on a sunny day, with the curiously irregular, verdant islands set in a sea of celestial blue, the shore lines marked by creamy surf, the ravines by brooks and waterfalls, the occasional depressions by small lakes shining in the sun. The sea abounds with fish; the offshore rocks are the resort of sea lions, and formerly of sea otters; the streams afford the trout-fisher abundant sport, and about their mouths the red salmon leap and play. In October the hillsides offer store of berries, and in all this land there is not a poisonous reptile or dangerous wild animal of any sort. The inhabitants of this land are an interesting and peculiar race."

The Underground Houses of Techin, Tunisia.—The curious underground houses of Techin, and other places near Gabes, in Tunisia, are described by M. Albert Tissandier, in *La Nature*, as being easily cut out of the clay-limestone rock. A square pit, twenty or twenty-five feet deep, is generally dug first to form a central court, from the lower part of which are made the grottoes that serve as sleeping and store rooms. A gently sloping gallery rising from the level of the bottom to the level outside, and closed by a modern door, is the means of communication with the country without, or forms a path to other houses. Niches are cut in the walls of the entrance court for storage of the agricultural implements and things of minor value, and silos are provided for the grain crops and oil jars. The rooms are lighted only through the doorway from the entrance court. They are furnished with mats and carpets. A bed and a wooden pedestal for the lamp, rudely carved and whitewashed like the walls of the cavern, form the principal ornaments, and a few primitive utensils of enameled earthenware are the principal articles of furniture. The size of the house and the number of rooms, etc., vary according to the wealth and station of the proprietor.

A Measure for Odors.—Very interesting studies have been made by M. Eugène Mesnard of the perfumes of flowers, valuable to science and to the perfumer's art. This art is still in a rather crude state because it has never found a practicable way of measuring an odor or of determining the strength of the several odors which it may seek to combine. M. Mesnard has observed, however, that though the absolute intensity of an odor can not be measured, its comparative strength can be estimated. A perfumer who has five or six hundred kinds of fragrance in his shop can readily distinguish the differences between them, although he can not tell how strong any of them are. So it is possible to detect by the smell the existence of a large number of chemical substances, although it is impossible to guess how much, if any, of them may be present in the air. Suppose, now, the author says, we pass in a given receiver air charged with a known perfume and air which has passed over a special essence—spirits of turpentine, for example. It is possible to obtain in this way a mixture of neutral odor, or such that a very slight variation of its constituents on either side will cause the special odor of the perfume or the smell of the turpentine to prevail. We can in such case regard the two odors as equivalent, and have only to seek a means of determining the intensity of the turpentine odor to have a measure of that of the perfume. A measure for the turpentine is obtained by means of the property which it has of extinguishing the phosphorescence of phosphorus. For that purpose a bit of common starch is employed which has been dipped in a sulphide-of-carbon solution of phosphorus. The sulphide evaporates and the starch remains, a homogeneous substance impregnated with phosphorus which shines in the air. The

shining may be extinguished, as M. Mesnard has shown, by the introduction of a quantity of air inversely proportioned to the strength with which it is charged with turpentine. Spirit of turpentine may thus be made a common standard for the different essences, and we may regard as the measure of the intensity of the perfume disengaged by a given weight of an essential oil the ratio between the weight of the turpentine which will neutralize the perfume and the weight of the same substance which under corresponding conditions will act upon phosphorescence with corresponding energy. M. Mesnard has devised an ingenious apparatus for performing practical measurements by the application of this principle.

Cordite.—According to the Industrial World, the manufacture of cordite is very simple. Nitroglycerin and dried gun cotton are mixed together in accurately weighed portions, the liquid nitroglycerin being poured over the gun cotton and mixed by hand until it is all taken up by the cotton, producing a dirty-white mass which looks much like sugar. This mass is then placed in kneading machines, which mix in the proper proportion of acetone. After several hours' kneading some vaseline is added and mixed in by further kneading. The mass finally becomes a stiff dough, which can be readily molded into any desired shape. The combination of nitroglycerin and gun cotton with acetone produces a compound quite different in appearance and properties from either of its components. Cordite is a heavy substance which burns only on the surface, the violence of whose explosion can hence be readily regulated by varying the relation between surface area and volume. Both nitroglycerin and gun cotton are very unstable. Cordite, on the other hand, is quite the reverse. Thus, a bonfire made around eight cases piled up against each other simply burned up the boxes and then the cordite, no explosion occurring.

Death of Prof. Ernst Curtius.—Dr. Ernst Curtius, Professor of History and the Fine Arts in the University of Berlin, who died July 12th, aged eighty-one years, was one of the most distinguished and most learned historians and archæologists of the century. He was born at Lübeck in 1814, of a family distinguished by love for literature and art; studied at Bonn, Göttingen, and Berlin; went with Prof. Brandeis in 1837 to Greece on an errand for the furtherance of archæological research; afterward, with Ottfried Müller, spent four years in Greece in historical and archæological studies, and began in 1864, but carried on with great activity after 1875, the excavations at Olympia which have been rewarded with the richest and most abundant treasures of classic art. From 1844 to 1849 he was extraordinary professor at the University of Berlin and tutor to the crown prince. In 1856 he was elected professor at Göttingen, but returned to Berlin as professor in 1868. His History of Greece is rivaled in merit only by Grote's, and is its fitting complement, supplying what Grote's lacks as Grote's supplies what it lacks, and is distinguished by the life it gives to the old legends and its appreciation of the artistic genius of the Greeks. He also published—works of equal merit in their respective fields—a book on the Acropolis of Athens (1844) and an account of the Discovery of Olympia (1882), besides many smaller works and monographs.

Plant Breeding.—In a recent copy of Nature M. T. Masters has an interesting article on Plant Breeding, from which the following extracts are taken: The natural processes of variation in the plant world as controlled by the art of the gardener are well typified in the garden rose of to-day—quite a different flower from those roses of our forefathers, which have, with a few exceptions, totally disappeared. It is the same with peas and potatoes and with most other plants that are grown on a large scale. The two methods made use of by gardeners for the improvement of plants are selection and cross-breeding, the latter, as far as results are concerned, only a modification of selection. The natural capacity for variation of the plant furnishes the basis on which the breeder has to work, and this capacity varies greatly in degree in different plants, so that some are much more amenable and pliant than others. The trial grounds of our great seedsmen furnish object lessons of this kind on a vast scale. The two processes are antagonistic. On the one hand, every care is

taken to preserve the breed and to neutralize variation as far as possible, so that the seed may "come true"; on the other hand, when the variation does occur, the observation of the grower marks the change, and he either rejects the plant, manifesting it as a "rogue," if the change is undesirable, or takes care of it for further trial if the variation holds out promise of novelty or improvement. Where the flowers lend themselves readily to cross-fertilization by means of insects, it is essential, in order to maintain the purity of the offspring to, grow the several varieties at a very wide distance apart. Some apparently slight variations, which even to the trained botanist are hardly noticeable, may be of great value commercially; as, for instance, of two apparently almost identical varieties of wheat one may be much better able to resist mildew and diseases generally than another. Some, again, prove to be better adapted to certain soils or for some climates than others. Some are less liable to injury from predatory birds, and so on. So far we have been alluding to variations in the plant as grown from seed, but similar changes are observable in the ordinary buds, and gardeners are not slow to take advantage of these variations. The field is one of great scientific as well as commercial interest, and a thoroughly equipped biologist would probably soon distance the ordinary gardener, who works by rule of hand, in producing and perpetuating valuable variations.

Some African War Customs.—When war comes to the Bondei people in Africa, the Rev G. Dale, missionary, says, the first who hears it climbs up to the top of the house and beats the drum with one hand, calling the people to assemble there. A drum is beaten in every village as soon as another drum is heard. Everybody goes where the first drum was sounded, and the people cry war all over the country. All the women and children go into the forest with their property, taking especial pains to carry the basket containing the money and beads. The warriors take their weapons, put their amulets on their arms and neck and face, and adjust their ostrich plumes. Each one supposes that the charms will keep him safe, and have power, even if he is struck with a bullet, to prevent its entering him. Another charm consists in scarifying the man all down his arms and breast and back, after which, it is believed, no sword will cut into his body. The great doctors have a powder which they put into water, which the warriors drink. On approaching the seat of war the warriors assemble, when every one is smeared on the face with a certain preparation and given medicine, and is licked by the *fundi*. Then they separate; each band goes in its special direction, and the battle takes place. If they conquer they return together singing songs signifying, "As the *kishundu* is a great bird and is accustomed to the mountains, so we are accustomed to war"; or, "Come and live in our land. That yonder is glowing with the fire of burned villages. We are like the Masai"; and entering the village they shout, "The land is at rest, till and eat!" If a man has been killed, they return singing, "My millet has a limit, who has eaten it?"—go to the house of the dead man, fire their guns, and take away the grass that slopes over the door—and so the wife knows that she is a widow. Then they go and tell the old folks. The man who has killed an enemy in battle performs a ceremony for seven days which includes climbing to the top of the house every morning, boasting, and naming the man he has killed. If the warriors are defeated, they come back one by one, having hidden themselves. In case of victory the women greet the warriors with great joy, and shave, for the first time since their husbands went to war.

Paints for Iron.—A new study of paints for iron has led Herr Spennrath to the conclusion that none of the metallic oxides entering into the composition of paints combines chemically with the oil. The drying of the paint is caused solely by the absorption of oxygen by the oil, which is facilitated in a purely mechanical way by the presence of the oxide. The relative value of the oxides is very variable. Oxide of zinc, when used in outside work, swells rapidly to twice the original volume, in consequence of the absorption of carbonic acid and the vapor of water. The red and white oxides of lead absorb sulphureted hydrogen and increase in volume. These substances are, however, good driers when they are pure. Carbon

paints are very stable, but their protecting power is not great. Herr Spennrath has attempted to explain the duration of different paints by means of comparative experiments on sheets of zinc. The painted zinc was dissolved in an acid, and films of paint were obtained and subjected to various tests. All were rapidly destroyed by the action of dilute hydrochloric or nitric acid, and of the vapors of sulphuric and acetic acids. Alkaline vapors likewise destroyed them rapidly. Pure water acts more rapidly than salt water, which goes to prove that corrosion by sea water is rather an effect of mechanical washing than of chemical action. Temperature, too, has a considerable influence on the resistance of paints. The films became brittle at a temperature of 95° C., and a perceptible contraction of the layer took place. Similar effects were produced on paints exposed for a long time to a low temperature.

August Kekulé.—August Kekulé, Professor of Chemistry in the University of Bonn, who died July 13th, sixty-six years old, left his mark on the science of chemistry in a distinct advance to which he gave the impulse. He was born at Darmstadt, in 1829, went to school there, and was then sent to Giessen, under the expectation that he would be educated to become an architect. But Liebig was at Giessen, and Kekulé's attention was turned to chemistry. Returning to Darmstadt, he studied chemistry under Moldenhauer, and then entered again as a student at Giessen under Liebig and Will. He afterward studied in Paris; sojourned for a short time in Switzerland as assistant to Von Plantu, at Reichenau; was engaged at St. Bartholomew's Hospital in London; established a laboratory, where he received pupils, at Heidelberg; and became professor, successively, at Ghent and Bonn. Kekulé's services to chemistry were chiefly in the theoretical field. The twenty-fifth anniversary of his promulgation of the benzene theory was celebrated at Berlin, in 1890, and the twenty-fifth anniversary of his professorship at Bonn, in that city, two years later. He took up Frankland's theory of valency and elaborated it; laid the foundation of the study of constitutional chemistry; gave the start to the fruitful investigation of the carbon compounds; and pointed the way to thousands of important experiments and was the inspiration of hundreds of valuable discoveries.

Drawing Upside Down.—Observations of children drawing upside down have been collected by Mr. Rina Scott, who says, in Nature, that a great many children draw in this way, while many from the first draw the right way up. He relates that a boy of four, when asked to draw a rook on a haystack, began at the bottom of the paper with the rook's back, and gradually worked his way up to the haystack; then turned the drawing round and asked his observer to look at it—evidently realizing that it was inverted. Mr. Scott does not find the explanation of the peculiarity in any inversion of the retinal image; for, if a child who draws upside down when drawing on a horizontal table, is asked to draw on a blackboard placed vertically, he will draw everything the right way upward. He supposes that when the object seen on a vertical plane is to be represented on paper placed in a horizontal plane—in which there is already a considerable divergence from the real appearance—it is simply a matter of convenience to him at which end he begins—both being equally wrong from his point of view. So children sometimes look at picture books upside down, and small children are more ready to draw objects which they have been accustomed to see in a horizontal plane, than erect objects. Mr. Alfred W. Bennett relates that he has been able all his life to read easily a book upside down, so that it makes no difference to him which way the book is presented. This is because, as he has been told, he first learned to read, upside down, by standing in front of a brother and looking over the top of the book from which he was being taught to read. The facility curiously extends to books in foreign languages, even those in which other alphabets—as Greek and Hebrew—than the Roman are used, and to nearly the same extent to handwriting. In a similar connection Mr. Hiram M. Stanley speaks of a strong native tendency in some children—and he might have added adults, for we have seen sign-painting in which that style was present—to reverse right and left in drawing such letters as J and L. He compares this confusion, and probably is

right, with the confusion of right and left which one first feels on using a mirror for toilet purposes.

School Conditions and Eyesight.—Dr. Brudenell Carter has taken up the question of the effect of school conditions on the eyesight, particularly as to whether they develop and aggravate short-sightedness and the other defects of vision which have been charged to them. He examined 8,125 children in twenty-five elementary schools of London. In forty per cent of them the eyes were right. The others were subjected to further special examinations. The author reports, as the general result of his investigation, that the proportion of cases of myopia was small, and that it bore no relation whatever to the lighting of the school; the two schools in which the greatest proportions of defective visions were found being respectively the best lighted and the worst lighted of the whole number. No evidence was found of progressive myopia. Some of the worst cases were found among children who had recently joined school, and there was nothing to show that it increased with the length of time the children had been at school. The proportion of cases of astigmatism was less than the proportion discovered in Dr. Carter's private practice among patients examined for every kind of optical weakness. The vast majority of optical defects were due to hypermetropia. The most unexpected result of the investigation was the discovery that a very large proportion of the cases of defective vision were due, not to structural defects in the refractive combinations of the eye, but to imperfect practice in seeing. Comparing the vision of children at a country school with the cases in the town schools, the author found the country vision much better. It is inferred that vision is strengthened by the habit of looking at objects at a distance, which are presented far more frequently in the expanses of rural landscapes than in the street-bounded sights of the town. Dr. Carter recommends that the vision be tested and trained systematically; that it be included among the physical faculties that are tested by competition and for proficiency in which prizes are given.

MINOR PARAGRAPHS.

The recent death of Lord Lilford, Thomas Lyttleton Powys, at the age of sixty-three, has removed one of the most devoted and conscientious of English ornithologists. He was interested in natural history from his earliest years, and was President for many years of the British Ornithologists' Union. His collection of live animals at Lilford Hall was widely celebrated. At the time of his death—which occurred at Lilford Hall on the 17th of June—he was engaged on a large work on the Birds of the British Islands.

Geology has sustained a severe loss in the death of Sir Joseph Prestwich, which occurred on June 23d. He was born at Clapham on March 12, 1812. He was engaged in business in London until sixty years of age, but during this time was able to gain such a reputation among geologists that upon the death of Prof. Phillips he was elected to the chair of Geology in the University of Oxford. His work as a pioneer in establishing the geological antiquity of man was recognized by the Royal Society in awarding to him a Royal medal in 1865. He continued to be a prolific writer up to the time of his death. Although he belonged to the old school of "catastrophists" which Sir Charles Lyell opened war on in 1830, and which today is a rapidly decreasing minority, he did much valuable and lasting work.

An ingenious method of destroying cattle ticks is described by Dr. M. Francis, a veterinarian of the Texas experiment station. After several unsuccessful attempts to destroy the ticks by various other means, the dipping process was adopted, and after trying several carbolic and arsenical solutions with unsatisfactory results, the cattle were forced to swim through a large vat of five thousand gallons capacity, on the surface of the water in which was a layer of cotton-seed oil, from three quarters to one inch in thickness, so that when they emerged they were perfectly covered with oil. It is well known that grease or oil of almost any kind is fatal to insects, lice, etc., and the above treat-

ment was found to be exceedingly fatal to the cattle tick, while in no way injuring the cattle.

It is reported that Dr. William W. Jacques, of Boston, an electrician and chemist, has succeeded in devising a practical commercial process for converting the energy contained in coal directly into electricity. His battery is constructed as follows: In an iron pot is placed caustic soda and heat applied up to 300°, when fusion occurs; into this fused mass is plunged a stick of carbon, and then air is forced through the solution. By the contact of the air with the carbon stick, in presence of the fused soda, oxidation is produced with no deterioration of the electrolyte, and upon connecting the carbon stick and the iron pot by means of a wire, an electric current is generated.

Electric tanning is thus described in the Journal of the Franklin Institute: The tanning pit has a capacity of fifteen thousand litres and is about eighty inches broad and ten feet long. Electrodes of nickeled copper are fixed to the longer walls of the pit, and in the latter the hides are so suspended that the current has to pass right through them. A current of twelve ampères with an E. M. F. of twelve volts is used. The tanning matter consists of oak extract, with a little hemlock extract added, both of which are cleared and decolorized by a special electrolytic process. By these means Folsing states that he has succeeded in obtaining good leather in seventy-two hours from light cowhides, in five days from heavy cowhides, and in six days from heavy oxhides.

A book by M. Georges Viret, on Legislation and Jurisprudence concerning useful and injurious insects and insectivorous birds, suggests some curious questions. In it are found the conditions under which bees are personal property, and others under which they are real. When bees are sent by mail, should they be classified as specimens or as letters? The French law says as letters, and our own postal laws have special provisions for packages of this sort. We learn from the book that when bees go astray on another man's land they are not trespassers, unless they are peculiarly malicious, and go about stinging or do some harm to men and animals. A question is suggested by the provision in French law which makes stealing bees in the daytime a smaller offense than stealing them in the night, the penalty being considerably more severe in the latter case than in the former. Possibly the law depends on the bees to do part of the punishing of the daytime thief. The table of contents of M. Viret's book shows that the law takes notice of nineteen kinds of insects, among which are bees, caterpillars, Colorado beetles, ants, wasps, beetles, cattle flies, olive flies, botflies, phylloxera, the woolly aphis, vine pyralis, grasshoppers, grubworms, and silkworms. Most attention is given to the phylloxera.

Mr. F. W. True, in the Proceedings of the National Museum, describes an armadillo of the genus *Xenurus* received from Honduras. He says: "This is the first instance, so far as I am aware, in which any representative of this genus has been found in Central America. . . . The head is short and blunt, and the extremity of the snout entirely naked for a distance of sixteen millimetres. The cephalic shield consists of about thirty-eight comparatively large plates. The ears are margined with a row of small, rounded scales, but otherwise entirely naked. The feet and outer side of the legs are covered with somewhat scattered flat, orbicular scales. The tail has similar flat scales about a millimetre and a half in diameter, imbedded in the skin at regular intervals; from the posterior margin of each scale one hair is exsected. Total length, one foot five inches; tail, six and a half inches. I have little hesitancy in referring this Honduras specimen to the *Dasypus* (*Xenurus*) *hispidus* of Burmeister."

The International Conference organized by the Royal Society to consider the preparation and publication of an International Catalogue of Scientific Literature was opened in London, July 14th. The efforts of the Royal Society to form a record and index of scientific literature date from the middle of the century, when the great authors' index was begun. A subject index to follow the authors' index was decided upon about thirty years ago, but was not started till 1893. As it soon became evident that the Royal Society alone was not competent to accomplish so large a work, the movement to secure international co-

operation was begun about two years ago. It has happily secured the support of governments and scientific societies in all parts of the world, and the meeting is very widely representative. The United States is represented by Dr. John S. Billings and Prof. Simon Newcomb; Canada by the Hon. Sir Donald A. Smith; and Great Britain by a large number of its most distinguished scientific men. Sir John A. Gorst, the British Government representative, was chosen president. Prof. Newcomb is one of the vice-presidents. The proceedings of the conference will be in English, French, and German, as the official languages.

NOTES.

It is stated that in Como, Italy, arrangements are being made for the holding in 1899 of an electrical exhibition and congress, to commemorate the centenary of the invention of the voltaic battery. Alessandro Volta was born in Como in 1745, but it was while Professor of Natural Philosophy at the University of Pavia that he made the discoveries that have immortalized his name.

The result of an inquiry made by the directors of the German telegraphs into the effect of the network of telephone wires in the large cities has been, according to *Das Wetter*, to show that the presence of the wires tends to reduce the violence of thunder and to diminish the dangers from lightning.

Probably the earliest known example of piece-molding among European bronze foundries is a mold for a spear head which was found at Thonon, France, among the relics of the lake-dwellers. It is described by Mr. George Simonds as having been composed of two slabs of stone, on each of which a spear head was cut out to a proper depth. The two stones, being placed face to face and bound together, would form a very simple but close mold from which many casts could be taken without injury to the mold itself.

It is stated by Mr. F. T. R. Carulla (England) that no effective remedy has yet been found for preventing the rusting of outdoor iron and steel work, and that in new railway lines iron and steel bridges are excluded wherever practicable. He stated, for instance, that over twenty tons of rust were taken from the Britannia Bridge during the first sixteen years after its completion.

A trial for larceny is mentioned in the Green Bag as having recently taken place in Ohio, in which the detective work of a dog was put in evidence. Some of the stolen property was found near the scene of the theft and was shown to the dog; he was then shown footprints close to it. Then, being put on the trail, he followed it unhesitatingly about two hundred feet to a gate, then inside the gate up to two front outside doors, of which he chose the left-hand one, and inside to the prisoner's door. He had been trained to this business, and could trail a culprit thus even along a track twenty or forty hours' old. The evidence was admitted.

The special commission appointed by the International Meteorological Congress in Munich in 1891 for the organization of observations on the direction of movement and the height of clouds having completed its work, observations were to be begun in all parts of the world on the 1st of May last, and are to be continued one year. The classification of clouds proposed by Hildebrandsson and Abercromby will be used as far as possible.

The death is announced, June 17th, of Lord Lilford (Thomas Lyttleton Powys), an eminent English ornithologist, in the sixty-fourth year of his age. He had a famous collection of wild animals, particularly full in the group of cranes, at his estate of Lilford Hall, and in knowledge of the habits of wild creatures, especially of birds, "had few equals." He was President of the British Ornithologists' Union, was a frequent contributor to The Zoölogist and The Ibis, was author of the Birds of Northamptonshire, and had nearly completed a book of Colored Figures of the Birds of the British Islands.

Dr. Heinrich Ernst Beyrich, Professor of Geology in the University and Director of the Natural History Museum in Berlin, recently died there, in his eighty-first year. He was a younger brother of the famous chemist, Ferdinand Beyrich, who died in 1869, and "was a most inspiring academical teacher, and gave a lively impulse to geological research." He published many papers on geology and paleontology, and was chief in making the geological map of Prussia and the Thuringian states.

Sir William Grove, an eminent lawyer, but most eminent as a man of science, died in London, August 1st. He was born at Swansea in 1811; was graduated from Oxford in 1830; was called to the bar in 1835, but, being in ill health, devoted himself to electrical researches, and in 1839 contrived the powerful battery that bears his name. By this and his researches on the conservation and transformation of energy he was best known. He was one of the original members of the Chemical Society, and was President of the British Association at the Nottingham meeting in 1866. A sketch of him, with portrait, was given in the Popular Science Monthly for July, 1875 (vol. iii, p. 363).

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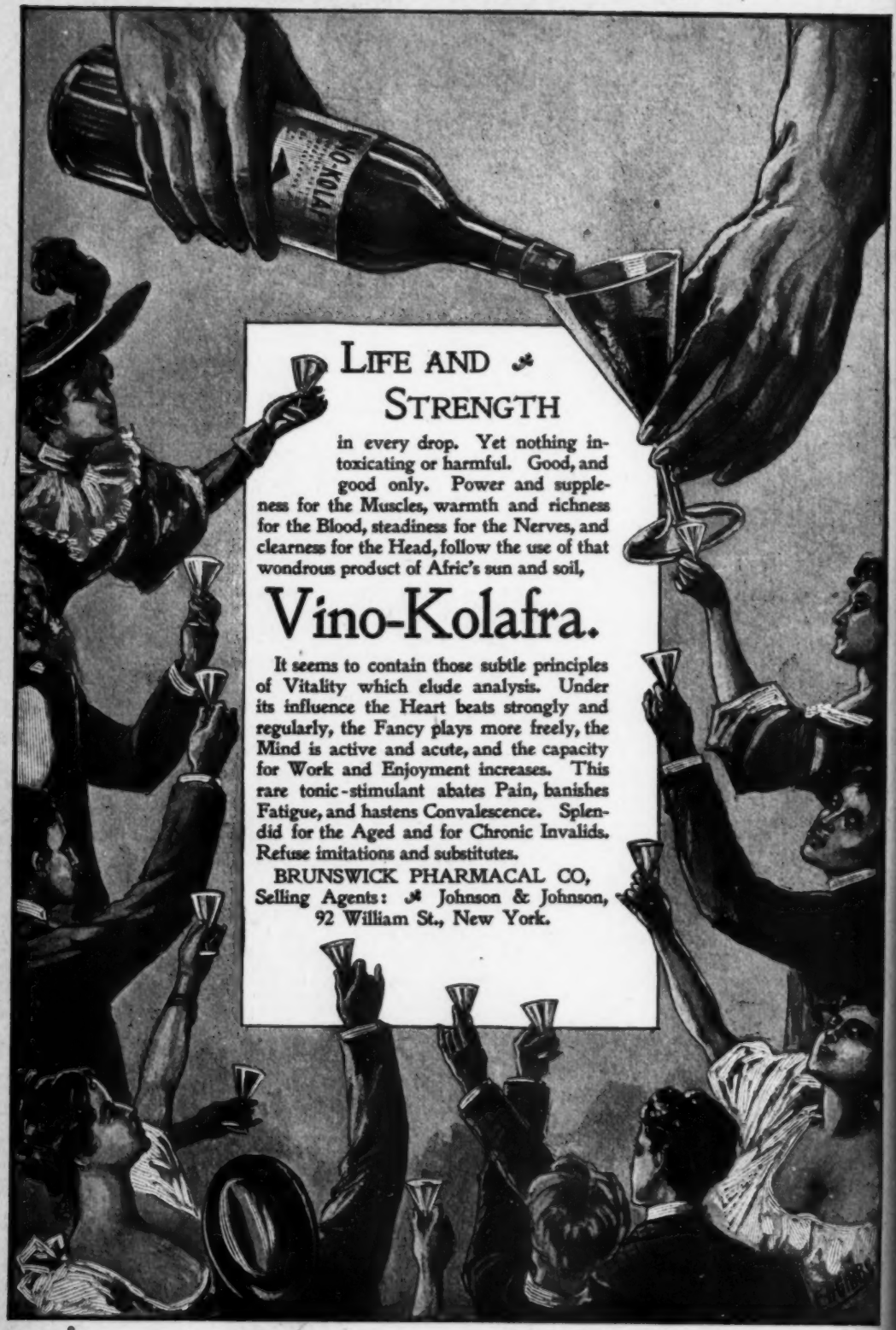

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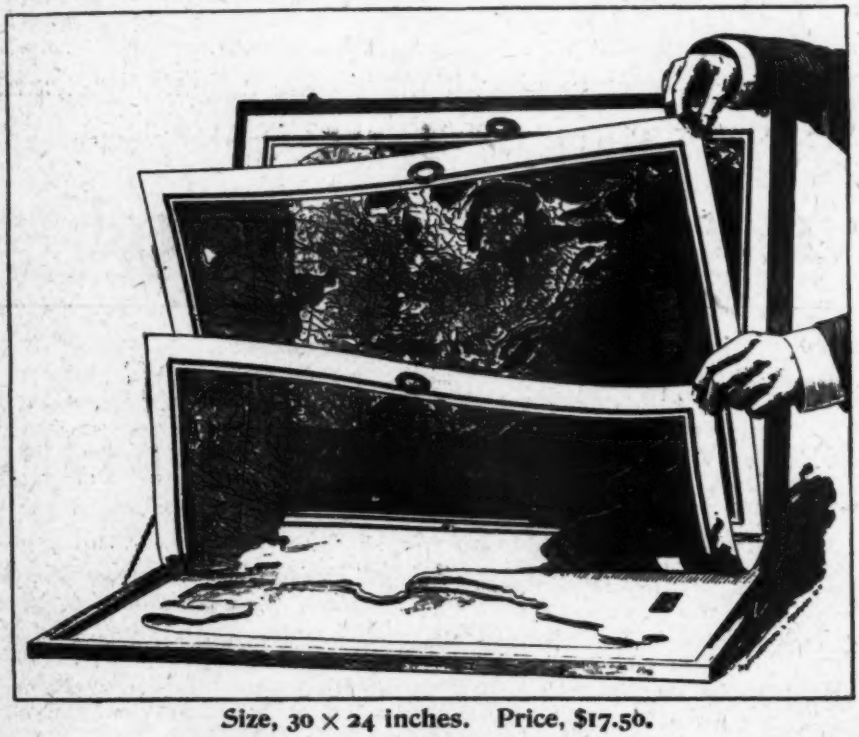

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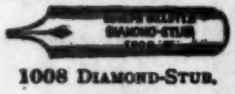

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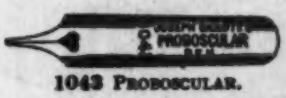

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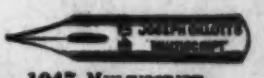

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